Table 2-1
Waste Management Unit Chronology

Waste Management Unit		72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02
Landfills	Former RCRA	-	-	-	-	-	-	-	-	-	-	GR	GR/W	W	V	V	V	V	R	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	PCB	-	-	-	-	-	-	GR/W	W	W	W	W	W	W	W	W	R/V	GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	P/S	-	-	-	-	-	-	GR/E	E/W	W	W	W	W	W	W	W	W	W/P	P	P	P	V	-	-	-	-	-	B	C	-	C	-
	Heavy Metals	-	-	-	-	-	-	GR	E/W	W	W	W	W	W	W	W	W	W/P	P	P	P	V	-	-	-	-	-	-	-	-	C	-
	Caustic/Cyanide	-	-	-	-	-	-	E	E/W	W	W	W	W	W	W	W	W	W/P	P	P	P	V	-	-	-	-	-	-	-	-	B	C
	Acids	-	-	-	-	-	-	E	E/W	W	W	W	W	W	W	W	W	W/P	P	P	P	V	-	-	-	-	-	-	-	-	-	C
Storage/	Pond 1	-	-	E	E	?	E	E/W	W	W	W	W	W	W	W	W	W	R	R/GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
Evaporation	Pond 2	-	-	L	L	?	W	W	W	W	W	W	W/E	W	W	W	W	W/R	R/GR	GR	GR	GR/V									V	V
Ponds	Pond 3	-	-	L	L	?	E/W	W	W	W	W	W	W	W	W	W	W	W/R	R/GR	GR	GR	GR	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Pond 4	-	-	-	E/L	?	E	W	W	W	W	W	W	W	W	W	W	R	R/GR	GR	GR	SW										
	Pond 5	-	-	-	-	-	-	-	E	E	W	W	W	W	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond 6	-	-	-	-	-	-	E/W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond 7	-	-	-	-	-	-	E/W	W	W	W	W	W	W	R	(converted to Pads 9A and 9B)						-	-	-	-	-	-	-	-	-	-	-
	Pond 8	-	-	-	-	-	-	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond 9	-	-	-	-	-	-	E/W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR											
	Pond 10	-	-	L	L	?	W	W	W	W	W	W	W	W	W	W	W	W/R	GR	GR	GR	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Pond 11	-	-	-	-	-	E/W	E/W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR											
	Pond 12	-	-	-	-	-	E	E	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR										
	Pond 13	E	E	L	L	?	E/W	W	W	W	W	W	W	W	W	W	W	R	R	GR	GR	GR/V	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Pond 14	-	-	-	L	?	E	W	W	W	W	W	W	W	W/R	L	L	R/GR	R	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond 15	-	-	-	-	-	E	E	V	V	V/E	E	E/W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 16	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 17	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 18	-	-	L	L	L	L	L	W	W	E/R	W	W	W	W	W	W	R	GR	GR	GR	TL	TL	TL	TL	TL	TL	TL	TL	TL	TL	TL
	Pond 19	-	-	-	-	-	-	?	E/W	W	W	W	W	W	W	W	W/B	W/R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 20	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R/GR	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 21	-	-	-	-	-	-	-	GR	GR	W	W	W	W	(converted to Pad 10E)					-	-	-	-	-	-	-	-	-	-	-	-	-
	Pond 22	-	-	-	-	-	-	-	-	-	-	-	E/W	W	W	W	W	R	R	R	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond 23	-	-	-	-	-	-	-	-	-	-	-	E	E/W	W	W	W	R/GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond A-1	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R	R	R	GR											
	Pond A-2	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R	R	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Pond A-3	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	W/R	R													
	Pond A-4	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R	R	GR	GR											
	Pond A-5	-	-	-	-	-	-	-	-	-	E	W	W	W	W	W	W	R	R/SW	SW	SW	SW	SW	SW	TL	TL	TL	TL	TL	TL	TL	TL
	Pond A-6	-	-	-	-	-	-	-	-	-	E	GR	W	W	W	W	W	R	GR	GR	GR	GR	GR	V	-	-	-	-	-	-	-	-
	Pond A	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	R/GR	GR	GR	GR	-	GR/V	-	-	-	-	-	-	-	-
	Pond B	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W/R	GR	GR	GR	GR	-	GR/V	-	-	-	-	-	-	-	-
	Pond C	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	R/GR	R/GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond D	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W/R	R	R/GR	R/GR	R/GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond E	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond J	-	-	W	W	W	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond L	-	-	E/W	W	W	W	W	W	W	W	W	W	W	W	W	W/R	R	GR	R/GR	R/GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond M	-	-	-	W	W	W	W	E/W	W	W	W	W	W	W	W	W	R	R/GR	GR	GR	GR	-	GR	-	-	GR	V	-	-	-	
	Pond P	-	-	-	-	-	E	W	W	W	W	W	W	W	W/R	L	L/R	L/R	R	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pond R	-	-	-	-	-	W	W	W	W	W/GR	W	E	R/GR	GR	GR/L	L	R	GR	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pond S	-	-	-	W	?	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR	-	V	-	-	-	-	-	-	-	-
	Pond T	-	-	-	-	?	W	W	W	W/E	E	E	E	E	GR	GR/W	GR/W	R	R/GR	GR	GR	GR	-	GR	-	-	GR	V	-	-	-	
	Pond V	-	-	-	-	-	W	W	W	W	W	W	W	W	W	W	W	R	GR	GR	GR	GR	-	V	-	-	-	-	-	-	-	-
	WCCB (Pond 43)	-	-	-	-	-	-	-	-	-	-	-	-	E/W	W	W	W	W	R	GR	GR	GR	-	GR/V	-	-	-	-	-	-	-	-

Table 2-1
Waste Management Unit Chronology

Waste Management Unit		72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02
Evaporation	Pad 1A	-	-	-	-	-	-	-	-	-	E	E	L	L	GR	GR	GR/V	R	R/GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
Pads	Pad 4A	-	-	W	W	W	W	W/V	V	W	W	V/W	R/GR	GR	GR	GR	V/W	R	R	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Pad 7A	-	-	-	-	-	-	-	-	-	-	-	-	-	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pad 8A	-	-	-	-	-	-	-	-	-	-	-	-	-	GR	GR	GR	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pad 8B	-	-	-	-	-	-	-	-	-	-	-	-	-	GR	GR	GR	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pad 8C	-	-	-	-	-	-	-	-	-	-	-	-	-	GR	GR	GR	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Pad 9A	-	-	-	-	-	-	-	-	-	-	-	E	E	W	W	W	R	GR	GR	GR	GR	-	V	-	-	-	-	-	-	-	-
	Pad 9B	-	-	-	-	-	-	-	-	-	-	-	E	E	W	W	W	R	GR	GR	GR	GR	-	V	-	-	-	-	-	-	-	-
	Pad 10A	-	-	-	-	-	-	-	-	-	-	-	-	-	W	W	W	R	GR	GR	V	V	-	-	-	-	-	-	-	-	-	C
	Pad 10B	-	-	-	-	-	-	-	-	-	-	-	W	W	W	?	GR	R	GR	GR	V	V	-	-	-	-	-	-	-	-	-	-
	Pad 10C	-	-	-	-	-	GR	GR	GR	W	W	W	W	W	W	W	W	R	R	GR	V	V	-	-	-	-	-	-	-	-	C	-
	Pad 10E	-	-	-	-	-	-	-	-	(Converted from Pond 21)					W	W	W	R	GR	GR	V	V	-	-	-	-	-	-	-	-	-	C
	Pad 10F	-	-	-	-	-	GR	GR	GR	W	W	W	GR	GR	GR	GR	GR	R	GR	GR	V	V	-	-	-	-	-	-	-	-	C	-
	Pad 10G	-	-	-	-	-	-	-	GR	W	W	W	GR	GR	GR	GR	GR	R	GR	GR	V	V	-	-	-	-	-	-	-	-	-	C
	Pad 18	-	-	-	-	-	-	-	-	-	-	V	W	GR	W	W	W	GR/R	R	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-
	Sludges 1	-	-	-	-	-	-	-	W	W	W	W	W	W	W	W	W/R	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	Sludges 2	-	-	-	-	-	-	-	-	-	-	-	-	-	W	W	W	R	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
Oil Field	S-1	-	-	-	-	-	-	-	-	W	W	W	W/GR	GR	GR	GR	GR	GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
Waste	S-2	-	-	-	-	-	-	-	-	-	W	W	W/GR	GR	GR	GR	GR	W/GR	GR	GR	GR	GR	-	GR	-	-	V	-	-	-	-	C
Spreading	S-3	-	-	-	-	-	-	-	-	W	W	W	W	GR	GR	GR	GR	GR	GR	GR	GR	GR	-	V	-	-	-	-	-	-	C	-
Areas	S-4	-	-	-	-	-	-	-	-	-	W	W	GR	GR	GR	GR	GR	GR	GR	GR	GR	GR	-	V	-	-	-	-	C	-	-	-
	S-5	-	-	-	-	-	-	-	-	-	-	GR	W	W	W/GR	GR	GR	W/GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
	S-6	-	-	-	-	-	-	-	-	-	-	GR	W	W	W	W	W	W/GR	GR	GR	GR	V	-	-	-	-	-	-	-	-	-	-
Waste	Well 1	-	-	-	-	-	-	-	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disposal	Well 2	-	-	-	-	-	-	W	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wells	Well 3	-	-	-	-	-	-	W	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 4	-	-	-	-	-	-	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 5	-	-	-	-	-	-	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 6	-	-	-	-	-	-	-	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 7	-	-	-	-	-	-	-	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 8	-	-	-	-	-	-	-	-	W	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 9	-	-	-	-	-	-	-	-	(never placed in service)					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 10	-	-	-	-	-	-	-	-	W	W	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Well 11	-	-	-	-	-	-	-	-	-	-	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waste	Trench 1	-	?	W	GR	?	GR	GR/V	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disposal	Trench 2	-	-	W	W	W	W	W	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trenches	Trench 3	-	-	W	W	W	W	W	GR	GR	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trench 4	-	-	-	-	-	W	W	W	GR	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trench 5	-	-	-	-	-	W	W	W	-	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trench 6							W	(incorporated into the PCB Landfill)							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Trench 7	-	-	-	-	-	-	-	W	-	GR/V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Treatment	CNS	-	-	-	-	-	-	-	-	-	-	-	-	-	GR	T	T	T	T	-	-	-	-	-	-	-	D	-	-	-	-	-
Units	Pilot PACT Unit	-	-	-	-	-	-	-	-	-	-	-	-	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Oil Recovery	-	-	-	-	-	-	-	T	T	T	T	T	T	T	T	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	H_2O_2	-	-	-	-	-	-	-	-	-	-	-	-	-	T	T	T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Zimpro WAO	-	-	-	-	-	-	-	-	-	-	GR	T	T	T	T	T	(Building retrofitted for proposed BLS - now used as Operations Building)														

Table 2-1
Waste Management Unit Chronology

Waste Management Unit	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02

Waste Management / Remediation Notations:
W = Waste disposal / contaminated liquids management
T = Treatment system operation
R = Remediation of soils and/or pond bottoms
P = Placement of remediate soils
C = Capping with final RCRA cap
B = Landfill buttress constructed
D = Decommissioned

Operational Notations:
SW = Conversion of excavated ponds into stormwater pond
TL = Conversion of pond into treated liquids impoundment

Photograph Notations:
L = Liquid noted in photograph - likely stormwater based on pond history
E = Excavation noted on photographs
GR = Graded area noted on photographs
V = vegetated area noted on photographs (shown for first year after remediation / grading only)
? = Activity likely based on records - photo not available
Aerial photograph available / reviewed for all years except 72, 73, 76, 93, 95, 96, 00 and 01,
Photo from unknown date in the 85/86 timeframe reviewed.

Sources:
A.T Kearney / SAIC, 1987
McClelland, 1989
Brierly and Lyman, 1990a-g, 1991a-l
Canonie Environmental, 1989b;
Aerial Photograph review (RI/FS Work Plan - Appendix J, CSC 2004a)

Table 2-2
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond 1	77-79		1	N	SI-3	1.0	1.4	3.21	4.2
Pond 2	77-79		1	H	SI-4	1.7	2.2	1.25	4.3
Pond 3	77-78		2	H	SI-5	2.3	2	7.37	8.8
Pond 4	77-79		1	N	SI-5	1.9	2	7.62	8
Pond 5	79	no design plans	3	N	SI-7	0.9	0.7	3.02	2.4
Pond 6	77-78	enlarged 79-80	3	M	SI-9	2.2	2.6	7.62	8.1
Pond 7		converted to Pads 9A and 9B							
Pond 8	78	enlarged 79-80	2	N	SI-7	1.9	1.9	10.93	9.6
Pond 9	78		2	H	SI-5	1.7	1.8	3.00	2.7
Pond 10	77-79	enlarged 79-80	3	N	SI-7	1.8	1.8	9.11	9.2
Pond 11	77-79	enlarged 79-80	3	N	SI-8	2.7	2.5	14.65	13.1

Table 2-2
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond 12	77-79	south dike moved 10' north in 84	N	N	SI-8	1.3	0.5	3.33	3.5
Pond 13	72-73	downgradient dike with 8' clay core, extends 54' bgs to 4 feet into gray claystone, modified to receive water from Pond 4 in 79	4	N	SI-6	1.5	1.3	7.10	6.2
Pond 14	78	no design plans, leakage noted in 84, pond excavated in 85	D	M	14	0.8	0.4	2.38	1.9
Pond 15	81	no design plans	D	M	SI-3	0.1	0.4	1.5	0.6
Pond 16	74	no design plans, pond silted in, overflow culvert plugged and pond taken out of service in 84	N	H	16	0.2	0.9	0.0	0.0
Pond 17	74	no design plans	1	H	SI-3	0.5	0.5	2.51	1.4
Pond 18	79	no design plans	D	N	SI-3	1.3	1.3	5.05	5.4
Pond 19	78	no design plans, expanded 79-80	3	M	SI-10	1.6	1	3.34	7.4
Pond 20	81-82	clay core barrier dam in SE corner	3	N	SI-8	0.6	0.7	2.90	1.4
Pond 21		converted to Pad 10E							

Table 2-2
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond 22	84	no design plans	3	N	SI-10	0.6	0.4	3.4	3.0
Pond 23	84 (82/83)	no design plans, compacted clay material on base and sideslopes	N	N	23	0.8	0.5	1.4	0.9
Pond A-1	82	clay core barrier along downgradient edge, extends 84' bgs to 4' into the unweathered gray claystone	N	N	SI-1	2.5	2.3	15.79	14.7
Pond A-2	82	clay core barrier along downgradient edge, extends 84' bgs to 4' into the unweathered gray claystone	N	N	SI-1	2.2	1.8	13.23	15.4
Pond A-3	82	clay core barrier along downgradient edge, extends 84' bgs to 4' into the unweathered gray claystone	2	N	SI-1	2.3	1.6	13.8	14.3
Pond A-4	82	expanded capacity in 1983 by raising dike 6'	1	N	SI-1	2.2	1.8	14.35	16.4
Pond A-5	82		D	N	SI-2	2.2	2.7	12.4	14.6
Pond A-6	83	no design plans	2	M	SI-1	0.9	NR	3.07	2.7
Pond A	72-73	periodically drained to Pond S by cutting spillway and reconstructing dike until 82, siphons installed in 78, plugged by 89	D	H	A	0.5	0.9	1.31	1.3
Pond B	72-73	periodically drained to Pond M by cutting spillway and reconstructing dike until 82, pipe installed in 78, plugged by 89	D	H	B	0.5	1	2.8	2.7
Pond C	72-73	periodically drained to Pond M by cutting spillway and reconstructing dike until 82, pipe installed in 78	D	H	C	0.8	1	5.33	5.3

Table 2-2
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond D	74	no design plans	D	M	D	0.2	1.4	0.0	0.0
Pond E	74	no design plans, 6-12" compacted clay constructed on base and sideslopes in 85	D	H	SI-4	0.9	0.5	2.24	2.4
Pond J	74	no design plans, 6-12" compacted clay constructed on base and sideslopes in 85	D	H	SI-4	0.9	0.9	2.9	2.4
Pond L	74	no design plans	N	H	SI-4	0.8	1.8	1.31	1.2
Pond M	75	no design plans, Pond M liquids transferred to Pond T during operation and then back to Pond M, base of both ponds raised due to accumulation of dried oil and drill cuttings	1	H	M	2.3	NR	0	3.3
Pond P	78	no design plans, leakage noted in 84, pond excavated in 85	D	M	P	0.6	0.7	2.1	2.2
Pond R	77	no design plans, silted in by 89	??	N	R	0.2	0.4	0.28	0.3
Pond S	77	no design plans	1	H	S	1.0	0.6	3.04	3
Pond T	75	no design plans, Pond M liquids transferred to Pond T during operation and then back to Pond M, base of both ponds raised due to accumulation of dried oil and drill cuttings	D	M	T	2.3	2.1	0.0	NR

Table 2-2
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pond V	77	no design plans	2	H	V	0.6	0.7	0.9	0.9
WCCB	newly constructed		NR	NR			.		
Pad 1A	85	not used for waste management	NR	N			1.6		
Pad 4A	85	may receive water from Pond J, drains to Pond 2	NR	N			0.9		
Pad 7A	85	receives water from riser and drains to Pond 8	NR	N			1		
Pad 8A	85	piped to receive water from site water supply riser, drains into Pond 20	NR	N			0.6		
Pad 8B	85	not used for waste management	NR	N			0.4		
Pad 8C	85	not used for waste management	NR	N			0.3		
Pad 9A	85	receives water from Pond 6, overflow from Pond R and drainage from Pad 9B; drains to Pond 6	NR	N			1.1		
Pad 9B	85	receives water from Pond 6 and loading dock area, drains to Pad 9A	NR	N			0.9		
Pad 10A	85	receives water from Pond 6 and drainage from Pad 10E, drains into Pond 19	NR	N			0.5		
Pad 10B	85	receives water from Pond 6, drains to Pond 19	NR	N			0.3		
Pad 10C	85	receives water from Pond 6, drains to Pond 19	NR	N			1.3		

Table 2-2
General Pond Information

Pond / Pad	Approx. Year Built (1)	Construction Notes (1)	Deposition Notation (1)	Class (1)	SI Unit (4)	Surface Area (acres) (2)	Surface Area (acres) (3)	Op. Capacity (mill. gall.) (2)	Op. Capacity (mill. gall.) (3)
Pad 10E	85	receives water from Pond 6, drains to Pad 10A	NR	N			0.9		
Pad 10F	85	receives water from Pond 6 and Pad 10G, drains to Pond 22	NR	N			0.5		
Pad 10G	85	receives water from Pond 6 and Pad 10F	NR	N			1.1		
Pad 18	83	known as Pad 3A in 1983, receives water from Pond 18, drains into Pond 18	NR	N			1.2		
S1	79	excavated spoils used to construct road embankment downgradient of Ponds 2, 3, 4, 10 and 11	NR	NR					
S2	85	includes concrete slab at north bank, drains to Pond 5	NR	NR					
					Totals	51	62	196	205

Source Documents:

(1) Existing Surface Impoundments Closure and Post-Closure Plan (Canonie, 1989a)
(2) RCRA Permit Application (Woodward-Clyde Consultants, 1985)
(3) Environmental Impact Report (McClelland, 1989)
(4) Existing Surface Impoundment: Design and Operations Report (Woodward-Clyde Consultants, 1987)

Depsotition Notation Legend (data from 1985 and 1986 deposit and transfer logs):

D Direct Deposit
1 First Generation Transfer
2 Second Generation Transfer
3 Third Generation Transfer
4 Fourth Generation Transfer
N No record of deposit or transfer after 1985

Class Legend:

H Hazardous
M Marginally Hazardous
N Nonhazardous

Table 2-3
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond 1	Feb-91	7.29' average excavation depth, 2 verification samples exceeded TCLs for metals, excavation ceased due to proximity to haul roads, groundwater and NTU Road, backfilled with material from below Pond 17	I	Some soil chemistry above TCLs, resampling and verification in progress	
Pond 2	No		C	Southeast corner contains minor organics	
Pond 3	Apr-91	6.53' average excavation depth, supplemental verification sampling indicated all below TCLs, dike between Ponds 2 and 3 completely removed	C	Verification sampling underway. North side to be closed with Pond M	
Pond 4	June 1988 (Canonie)	8' maximum excavation depth, closure samples evaluated statistically, results indicate that closure samples are statistically below TCLs	C	Some metals above background and low-level organics at south and west dike. South dike to be closed with NTU Road.	
Pond 5	Dec-90	12.2' average excavation depth, all final verification samples below TCLs	C		
Pond 6	Feb-91	report for eastern 2/3 of pond only, western 1/3 may be impacted by leachate from the P/S Landfill, 8.16' avarage excavation depth (to an apparent low spot in the claystone), all verification samples below TCLs, future closure to address closure of western pond and the northwestern portion of the pond comprised of dike material originally between Ponds 6 and 9	C - East 2/3 LF - West 1/3	East side closed, west side being considered for landfill closure.	East side closed, west side being considered for landfill closure.
Pond 7	NA		NA		
Pond 8	Oct-90	6.27' average excavation depth, all verification samples all below TCLs, closure included removal of damp soil and pipe in the northwest corner of the pond	C	Review and follow-up inspection	

Table 2-3
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond 9	No		I	initial inspection - two verfication samples taken	
Pond 10	Dec-90	8.83' average excavation depth, 2 verification samples near western dike exceeded TCLs for metals, all dike material subsequently removed without additional testing	C	Dikes removed, benzene below TCLs detected at south bank	
Pond 11	Feb-91	6.36' average excavation depth, all verification samples below TCLs	C		
Pond 12	Feb-91	2.09' average excavation depth, removed damp soils in NE and NW corners of the pond, pond backfilled and coated with asphaltic emulsion, verification samples exceeded TCLs for lead, baruim and arsenic, subsequent verification samples obtained by drilling - arsenic below TCLP, lead at ND but detection limit greater than TCLP	C		
Pond 13	No		C	Organic contamination beyond northeast pond limit noted and recommended for separate closure.	
Pond 14	No		I	Initial inspection, originally considered for landfill closure, currently working on closure by removal	Requires agency walkthrough
Pond 15	Feb-91	6.2' average excavation depth, verification sample results below TCLs with the exception of barium and reactive sulfide, soil in the area of elevated concentrations subsequently excavated during Pad 18 closure	C		
Pond 16	No		C		

Table 2-3
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond 17	Feb-91	5.12' average excavation depth, one verification sample location exceeded TCL for nickel, additional 20' excavation taken to facilitate drainage (used to backfill Pond 1) with no additional testing	C	Resampled for nickel - results pending	
Pond 18	No		C		
Pond 19	No		C - south dike recommended for landfill closure	Recommended for closure except for south dike and adjacent fill material	South dike and SW corner - close as landfill
Pond 20	Feb-91	4.99' average excavation depth, all verification samples below TCLs	C		
Pond 21	NA		NA		
Pond 22	No		C		
Pond 23	No		LF		close as landfill
Pond A-1	Mar-91	5.32' average excavation depth, all verification samples below TCLs, diesel fuel contamination left in south bank area (source is fuel tank across road), no additional axcavation due to proximity to road	C		
Pond A-2	Mar-91	7.14' average excavation depth, all verification samples below TCLs, 100 cy used to construct Pond A-3 access road	C		
Pond A-3	Jan-91	3.4' average excavation depth, all verification samples below TCLs	C		

Table 2-3
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond A-4	Mar-91	1.32' average INITIAL excavation depth, after additional 6' excavation all verification sample results below TCLs	C		
Pond A-5	No		I	Review and follow-up inspection - verification sampling assigned, lab results pending	
Pond A-6	No		C		
Pond A	No		I		Requires agency walkthrough
Pond B	No		I		Oil seeps observed in test pits - requires agency walkthrough
Pond C	No		I		Oil seeps observed in test pits - requires agency walkthrough
Pond D	No		C		Includes washrack
Pond E	No		C		
Pond J	No		I	Recommended for closure - pending oil result evaluation	Resolve oil seep analysis
Pond L	No		C		

Table 2-3
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pond M	No		I	Initial inspection	
Pond P	No		I	Initial inspection - originally considered for landfill closure, currently working on closure by removal	Requires agency walkthrough
Pond R	No		LF	Recommended dlosure as landfill - observed and photodocumented	Close as landfill
Pond S	No		I		Requires agency walkthrough
Pond T	No		I	Initial inspection	Requires agency walkthrough
Pond V	No		I	Initial inspection	Requires agency walkthrough
WCCB	No		C		Requires agency walkthrough
Pad 1A	No		C		
Pad 4A	No		C		
Pad 7A	No		C		

Table 2-3
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
Pad 8A	Nov-90	1' excavation depth, the one verification sample result was below TCLs	C		
Pad 8B	Nov-90	1' excavation depth, the one verification sample result was below TCLs	C		
Pad 8C	Dec-90	1' excavation depth, nickel exceeded TCLs in 2 closure sample locations, no verification samples collected	LF		
Pad 9A	No		LF	Under consideration for landfill closure	Close as landfill
Pad 9B	No		C	Under consideration for landfill closure	Close as landfill
Pad 10A	No		C		
Pad 10B	No		C		
Pad 10C	No		C		
Pad 10E	No		C		
Pad 10F	No		C		
Pad 10G	No		C		
Pad 18	No		C	Recommended for closure - area beyond northern limit of Pad 18 to be closed with RCRA Canyon	

Table 2-3
Pond Closure Information

Pond / Pad	Closure Report (5)	Excavation and Sampling Notes (5)	Closure Rec. (6)	Status as of September 1990 (6)	Status as of March 1992 (7)
S1			C		
S2			C		

Source Documents:

(5) Closure Certifications Reports for Ponds and Pads (Brierley & Lyman, 1990a-g and 1991a-l, Canonie, 1988b)
(6) Brierley and Lyman 11-9-90 lettter to RWQCB (Brierley and Lyman, 1990a)
(7) Revised Groundwater Monitoring Program (Casmalia Resources, 1992)

Closure Recommendations Legend:

LF Recommended for closure as landfill
I Closure process incomplete, constituents in excess of TCLs locally left in place
C Recommended for closure

TABLE 2-4
Contaminated Liquids Extraction, Treatment, and Disposal

		Gallery Well				Sump 9B				PSCT				PCTs			
Entity	Year	Const	Ext	Tmt	Disposal	Const	Ext	Tmt	Disposal	Const	Ext	Tmt	Disposal	Const	Ext	Tmt	Disposal
O/O	1980	X	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1981	-	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1982	-	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1983	-	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1984	-	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1985	-	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1986	-	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1987	-	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1988	-	X	none	P/S LF	-	-	-	-	-	-	-	-	-	-	-	-
O/O	1989	-	-	-	-	X	X	Solidification	P/S LF	-	-	-	-	X	X	none	RCF, A-Series
O/O	1990	-	X	none	Offsite TSD, TX	-	X	Solidification	P/S LF	X	-	-	-	-	X	none	RCF, A-Series
O/O	1991	-	X	none	Offsite TSD, TX	-	-	-	-	-	-	-	-	-	X	none	RCF, A-Series
EPA[1,2]	1992	-	X	none	Offsite TSD, NJ	-	-	-	-	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
EPA[1]	1993	-	X	none	Offsite TSD, NJ	-	-	-	-	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
EPA[1]	1994	-	X	none	Offsite TSD, NJ	-	X	none	Offsite TSD, NJ	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
EPA[1]	1995	-	X	none	Offsite TSD, NJ	-	X	none	Offsite TSD, NJ	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
EPA[1]	1996	-	X	Bio/PACT	Pond A-5	-	X	Bio/PACT	Pond A-5	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
CSC[3]	1997	-	X	Bio/PACT	Pond A-5	-	X	Bio/PACT	Pond A-5	-	X	GAC	Pond 18/A5	-	X	none	RCF, A-Series
CSC	1998	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18/A5	-	X	none	RCF, A-Series
CSC	1999	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2000	-	X	none	Offsite TSD, CA	-	X	ATS/GAC	Pond 18	-	X	ATS/GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2001	-	X	none	Offsite TSD, CA	-	X	ATS/GAC	Pond 18	-	X	ATS/GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2002	-	X	none	Offsite TSD, CA	-	X	ATS/GAC	Pond 18	-	X	ATS/GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2003	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2004	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2005	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2006	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2007	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2008	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18	-	X	none	RCF, A-Series
CSC	2009	-	X	none	Offsite TSD, CA	-	X	none	Offsite TSD, CA	-	X	GAC	Pond 18	-	X	none	RCF, A-Series

Notes:

O/O Owner/Operator
EPA U.S. Environmental Protection Agency
CSC Casmalia Steering Committee
P/S LF Pesticide/Solvent landfill
Bio/PACT Biologically-activated/Powdered activated carbon treatment
GAC Granular activated carbon
ATS Ameripure treatment system
TSD Treatment/Storage/Disposal

1 The Owner/Operator controlled PCT extraction from 1992 through 1996.
2 USEPA Emergency Response Section began oeprations at the site in August 1992.
3 The CSC took over site operations from EPA on September 17, 1997

Table 4-1
Meteorological Data Summary For Site
Temperature and Wind Speed (2006-2007)

A Drainage	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07
WS High (MPH)	11.06	5.29	6.16	8.44	7.13	9.24	11.79	9.52	7.93	11.27	12.42
WS Low (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS Ave (MPH)	1.99	1.65	1.55	1.60	1.53	2.76	2.29	1.91	2.25	2.19	2.74
WD (Deg)	0.00	181.00	214.00	197.00	226.00	237.00	230.00	190.00	238.00	221.00	244.00
B Drainage	**Jun-06**	**Jul-06**	**Aug-06**	**Sep-06**	**Oct-06**	**Nov-06**	**Dec-06**	**Jan-07**	**Feb-07**	**Mar-07**	**Apr-07**
WS High (MPH)	4.79	4.51	3.19	4.22	5.26	4.76	6.75	5.82	5.09	4.85	5.10
WS Low (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS Ave (MPH)	1.43	1.27	0.92	0.98	0.98	1.54	1.37	1.23	0.90	1.37	1.67
WD (Deg)	186.00	186.00	201.00	198.00	163.00	100.00	106.00	112.00	138.00	140.00	159.00
North Perimeter	**Jun-06**	**Jul-06**	**Aug-06**	**Sep-06**	**Oct-06**	**Nov-06**	**Dec-06**	**Jan-07**	**Feb-07**	**Mar-07**	**Apr-07**
Temp High (DGC)	31.80	31.00	28.50	28.50	27.20	29.50	23.60	26.50	26.20	30.00	25.90
Temp High (DGF)	89.24	87.80	83.30	83.30	80.96	85.10	74.48	79.70	79.16	86.00	78.62
Temp Low (DGC)	9.00	8.90	9.60	9.60	9.30	5.60	4.90	0.60	4.60	4.50	6.20
Temp Low (DGF)	48.20	48.02	49.28	49.28	48.74	42.08	40.82	33.08	40.28	40.10	43.16
Temp Ave (DGC)	16.30	17.80	15.30	15.60	16.00	15.30	13.40	10.80	11.50	13.20	12.60
Temp Ave (DGF)	61.34	64.04	59.54	60.08	60.80	59.54	56.12	51.44	52.70	55.76	54.68
WS High (MPH)	13.17	7.20	8.42	11.52	11.68	15.33	19.74	17.37	14.26	17.48	19.31
WS Low (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS Ave (MPH)	3.15	1.87	2.13	2.33	3.00	5.15	4.58	4.10	4.07	3.70	4.51
WD (Deg)	181.00	123.00	160.00	156.00	187.00	206.00	183.00	123.00	192.00	169.00	224.00

WS = Wind Speed
WD = Wind Direction (degrees from north that wind is blowing from)

DGC = Degree in Centigrade
DGF = Degree in Fahrenheit

Data Source Casmalia Landfill Meteorological Monitoring Program, Monthly Reports
(January through December) 2007. EMC

TABLE 4-2
METEOROLOGICAL DATA SUMMARY FOR SITE
EVAPORATION AND RAINFALL (1996-2007)

Month	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Evaporation Data[1] (inches)											
October	5.20	5.40	4.79	3.32	3.20	3.93	3.20	4.20	3.18	3.54	3.18
November	2.50	2.40	2.46	2.93	3.20	2.50	2.83	2.96	2.22	3.41	3.24
December	2.82	2.40	2.05	2.87	1.77	2.30	1.41	1.63	1.59	3.24	2.53
January	0.00	1.90	1.97	2.14	1.45	2.91	2.63	2.42	1.08	2.98	2.14
February	4.68	1.90	2.96	NR	3.94	4.10	2.36	1.63	1.99	2.77	2.43
March	5.50	3.70	3.51	5.03	4.19	4.51	4.14	3.58	2.81	2.22	3.98
April	6.00	5.00	4.37	4.42	5.84	5.50	4.42	4.80	4.76	3.14	4.56
May	6.75	5.70	5.40	5.20	7.04	5.65	6.05	5.52	5.33	4.12	4.74
June	6.50	5.50	5.80	5.46	7.05	5.39	5.04	5.52	5.52	5.49	--
July	6.50	6.60	5.20	5.50	6.68	5.68	5.40	5.40	5.40	4.85	--
August	7.00	6.70	4.80	5.20	7.17	4.44	5.44	5.40	4.08	4.20	--
September	6.75	4.60	4.00	4.83	5.04	4.94	4.44	5.04	5.47	3.51	--
Water Year Totals	60.20	51.80	47.31	46.90	56.57	51.85	47.36	48.10	43.43	43.47	26.82

TABLE 4-2 (CONTINUED)
METEROLOGICAL SUMMARY FOR SITE
EVAPORATION AND RAINFALL DATA (1996-2007)

Month	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Rainfall Data[1] (inches)											
October	0.00	0.00	0.19	0.00	1.82	0.60	0.10	0.00	2.61	0.98	0.38
November	4.12	2.66	3.57	1.41	0.00	2.89	2.81	2.50	0.98	1.11	0.45
December	4.52	5.72	0.44	0.09	0.33	2.10	3.49	2.04	4.52	1.95	1.66
January	5.03	3.77	2.21	2.17	6.41	1.11	0.29	0.93	5.38	4.39	1.48
February	0.18	11.65	1.20	7.20	5.97	0.37	2.35	5.04	3.74	1.06	2.29
March	0.00	3.10	6.58	2.04	2.95	1.10	1.57	0.72	3.21	3.98	0.17
April	0.00	3.60	1.84	3.02	1.87	0.39	1.17	0.00	0.70	3.80	0.60
May	0.00	1.80	0.00	0.00	0.00	0.00	0.96	0.00	1.41	1.25	0.08
June	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.06	--
July	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--
August	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	--
September	0.00	0.35	0.00	0.04	0.00	0.02	0.00	0.00	0.09	0.09	--
Water Year Totals	14.00	32.65	16.12	16.05	19.35	8.58	12.74	11.23	22.64	18.67	7.11

Note: Water Year occurs from between October 1 of the previous year to September 30 of the indicated year.

-- – Data not available

[1] Data source for site meteorological evaporation and precipitation data collected since September 1996 by CSC is Casmalia Resources Site Remediation Quarterly Progress reports prepared by CSC for EPA. Data source for evaporation and precipitation data from facility meteorological station measurements prior to September 1996 is facility records maintained on site.

TABLE 5-1
General RI/FS Data Needs

Data Needs / Areas	Potentially Contaminated Media								
	Surface Soil (0 - 0.5')	Subsurface Soil Shallow (0.5 - 5')	Subsurface Soil Mid to Deep (>5')	Surface/Sub surface Vapor	Surface Water Ponds	Surface Water Runoff/Seeps	Sediment	Groundwater	Potential NAPL
Background Chemical Characterization									
On-site Uncapped Areas	HH, Eco	HH, Eco							
Off-site Areas	HH, Eco	HH, Eco		HH				GW	
Site Chemical Characterization									
Capped Landfills				HH, Eco		HH, Eco, FS		GW, TI, FS	TI, FS, GW
PCB Landfill				HH, Eco, FS				GW, TI, FS	
RCRA Canyon Area	HH, Eco, FS	HH, Eco, FS	GW, FS			HH, Eco, FS	HH, Eco, FS	GW, FS	TI, FS, GW
West Canyon Spray Area	HH, Eco, FS	HH, Eco, FS	GW, FS						
Burial Trench Area	HH, Eco, FS	HH, Eco, FS	GW, FS	HH, Eco, FS				GW, TI, FS	TI, FS, GW
Central Drainage Area	HH, Eco, FS	HH, Eco, FS	GW, FS	HH, Eco, FS		HH, Eco, FS		GW, TI, FS	TI, FS, GW
Liquids Treatment Area	HH, Eco, FS	HH, Eco, FS	GW, FS	HH, Eco, FS				GW, FS	TI, FS, GW
Maintenance Shed Area	HH, Eco, FS	HH, Eco, FS	GW, FS					GW, FS	TI, FS, GW
Administrative Building Area	HH, Eco, FS	HH, Eco, FS	GW, FS					GW, FS	
Roadways	HH, Eco, FS	HH, Eco, FS							
Remaining On-site Areas	HH, Eco, FS	HH, Eco, FS	GW, FS					GW, FS	TI, FS, GW
Off-Site Areas	HH, Eco, FS	HH, Eco, FS				HH, Eco, FS	HH, Eco, FS	GW, FS	
Stormwater Ponds					HH, Eco, FS		HH, Eco, FS		
Treated Liquids Impoundments					FS		HH, Eco, FS		
Fate and Transport		HH, Eco, FS	FS, GW	HH, Eco, FS				GW, TI, FS	TI, FS, GW
Site Flow Characterization									
North Perimeter								GW	
PSCT								GW	
South Perimeter								GW	
Additional Planning Information									
Delineate P/S Landfill Clay Barrier (for GW study)									
Conduct Off-site Well Survey (for GW study)									
Complete Biological Species Surveys (for Eco)									
Conduct TOC Studies (for FS)									
Collect Select Physical Soil Data (for HH, Eco and FS)									

Legend:
HH Data needed for Human Health Risk Assessment
Eco Data needed for Ecological Risk Assessment
GW Data needed for Groundwater Characterization / Modeling
TI Data needed for TI Evaluation
FS Data needed for Feasibility Study
TOC Total Organic Carbon

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
Inorganics							
	Aluminum (Total)	7429-90-5	•		◦	•	•
	Antimony (Total)	7440-36-0	•		◦	•	•
	Arsenic (Total)	7440-38-2	•		◦	•	•
	Barium (Total)	7440-39-3	•		•	•	•
	Beryllium (Total)	7440-41-7	•		◦	•	•
	Cadmium (Total)	7440-43-9	•		•	•	•
	Calcium (Total)	7440-70-2	•		•	•	•
	Chromium (Total)	7440-47-3	•		•	•	•
	Cobalt (Total)	7440-48-4	•		◦	•	•
	Copper (Total)	7440-50-8	•		•	•	•
	Iron (Total)	7439-89-6	•		•	•	•
	Lead (Total)	7439-92-1	•		•	•	•
	Magnesium (Total)	7439-95-4	•		•	•	•
	Manganese (Total)	7439-96-5	•		•	•	•
	Mercury (Total)	7439-97-6	•		•	•	•
	Molybdenum (Total)	7439-98-7	•		•	•	•
	Nickel (Total)	7440-02-0	•		•	•	•
	Potassium (Total)	7440-09-7	•		•	•	•
	Selenium (Total)	7782-49-2	•		•	•	•
	Silver (Total)	7440-22-4	•		--	•	•
	Sodium (Total)	7440-23-5	•		•	•	•
	Thallium (Total)	7440-28-0	•		•	•	•
	Tin (Total)	7440-31-5	•		•	•	•
	Vanadium (Total)	7440-62-2	•		◦	•	•
	Zinc (Total)	7440-66-6	•		•	•	•
	Cyanide (Amenable)	57-12-5-C / A57-	•			--	•
	Cyanide (Free)	57-12-5				•	•
	Cyanide (Total)	57-12-5	•		--	--	
	Hydrazine	302-01-2					•
	Hydrogen Cyanide	74-90-8	•				
	Hydrogen Sulfide	7783-06-4	•				

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
Volatile Organics							
	1,1,1-Trichloroethane	71-55-6	•	•	•	--	•
	1,1,2,2-Tetrachloroethane	79-34-5	•	--	--	--	•
	1,1,2-Trichloro-1,2,2-trifluoroethane	HLA-0191					•
	1,1,2-Trichloroethane	79-00-5	•	•	--	--	•
	1,1-Dichloroethane	75-34-3	•	•	•	•	•
	1,1-Dichloroethylene	75-35-4	•	•	•	•	•
	1,2,3-Trichlorobenzene	87-61-6	•		--	--	•
	1,2,3-Trichloropropane	96-18-4	•		--	--	•
	1,2,4-Trimethylbenzene	95-63-6	•	•	--	--	•
	1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	•		--	--	•
	1,2-Dibromoethane	106-93-4	•	--	--	•	•
	1,2-Dichloroethane	107-06-2	•	--	--	--	•
	1,2-Dichloroethylene,total	540-59-0	•		•	--	•
	1,2-Dichloropropane	78-87-5	•	•	•	--	•
	1,3,5-Trimethylbenzene	108-67-8	•	•	•	--	•
	1,3-Butadiene	106-99-0		•			
	2-Butanol	78-92-2	•		--	--	•
	2-Chlorotoluene	95-49-8	•		--	--	•
	2-Hexanone	591-78-6	•	•	--	--	•
	3,3,5-Trimethylcyclohexanone	873-94-9	•		•	--	•
	4-Ethyltoluene	622-96-8		•			
	Allyl chloride	107-05-1	•	--	--	--	--
	Benzene	71-43-2	•	•	•	•	•
	Bromobenzene	108-86-1	•		--	--	•
	Bromochloromethane	74-97-5	•		--	--	•
	Bromodichloromethane	75-27-4	--	--	--	--	•
	Bromoform	75-25-2	•	--	•	--	•
	Bromomethane	74-83-9	•	•	--	--	•
	Butane	106-97-8		•			
	Carbon disulfide	75-15-0	•	•	•	•	•
	Carbon tetrachloride	56-23-5	•	•	--	--	•
	Chlorobenzene	108-90-7	•	--	--	--	•
	Chloroethane	75-00-3	•	•	--	--	•

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
	Chloroform	67-66-3	•	•	•	•	•
	Chlorotrifluoroethene	79-38-9	•		--	--	•
	cis-1,2-Dichloroethene	156-59-2	--	•		•	•
	Cyclohexane	110-82-7		•			
	Cyclohexanone	108-94-1					•
	Dibromochloromethane	124-48-1	•	--	--	--	•
	Dichlorodifluoromethane	75-71-8	•		--	--	•
	Diisopropyl ether	108-20-3	•		•	--	•
	Ethylbenzene	100-41-4	•	•	•	--	•
	Freon 112	76-12-0	•		--	--	•
	Freon 113	76-13-1	•	•	•	•	•
	Heptane	142-82-5		•			
	Hexane	110-54-3		•			
	Isobutylene	115-11-7		•			
	Isopropylbenzene	98-82-8	•		--	--	•
	m,p-Xylene	108-38-3	•	•			
	m-Dichlorobenzene	541-73-1	•	--	--	--	•
	Methyl Acetate	79-20-9	•		--	--	•
	Methyl chloride	74-87-3	•	•	--	•	•
	Methyl iodide	74-88-4	•		--	--	•
	Methyl tert-butyl ether (MTBE)	1634-04-4	•	--	--	•	•
	Methylcyclopentane	96-37-7	•		•	--	•
	Methylene chloride	75-09-2	•	•	•	•	•
	n-Butylbenzene	104-51-8	•		--	--	•
	Nonanal	124-19-6	•		--	•	•
	n-Propylbenzene	103-65-1	•		--	--	•
	o-Dichlorobenzene	95-50-1	•		•	--	•
	o-Xylene	95-47-6	•	•	--	--	•
	p-Dichlorobenzene	106-46-7	•	•	--	--	•
	p-Isopropyltoluene	99-87-6	•		--	•	•
	Propanal	123-38-6	•		•	•	•
	sec-Butylbenzene	135-98-8	•		--	--	•
	Styrene	100-42-5	•	•	--	--	--
	tert-Butylbenzene	98-06-6	•		--	--	--

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
	Tetrachloroethylene	127-18-4	•	•	•	--	•
	Tetrahydrofuran	109-99-9	•	•	•	•	•
	Toluene	108-88-3	•	•	•	--	•
	trans-1,2-Dichloroethylene	156-60-5	•		--	--	•
	Trichloroethylene	79-01-6	•	•	•	•	•
	Trichlorofluoromethane	75-69-4	•	•	--	--	•
	Trifluoromethylbenzene	98-08-8	•		--	--	•
	Vinyl acetate	108-05-4	•	--	--	--	--
	Vinyl chloride	75-01-4	•	•	--	--	•
	Xylene (total)	1330-20-7	•		•	--	•
Semivolitile Organics							
	(-)-Globulol	489-41-8	•				
	1,2,4,5-Tetrachlorobenzene	95-94-3	•		--	--	--
	1,2,4-Trichlorobenzene	120-82-1	•	--	--	--	•
	1,3,5-Trinitrobenzene	99-35-4	--		--	--	•
	1,3-Dinitrobenzene	99-65-0	--		--	--	•
	1H-Cycloprop[e]azulene, decahydro-	25246-27-9	•				
	1R-.alpha.-Pinene	7785-70-8	•				
	2,3,4,6-Tetrachlorophenol	58-90-2	•		--	--	•
	2,4,5-Trichlorophenol	95-95-4	--		--	--	•
	2,4-Dichlorophenol	120-83-2	•		--	--	•
	2,4-Dimethylphenol	105-67-9	•		--	--	•
	2,4-Dinitrotoluene	121-14-2	•		--	--	--
	2,6-Dichlorophenol	87-65-0	--		--	--	•
	2,6-Dinitrotoluene	606-20-2	•		--	--	•
	2-Chlorophenol	95-57-8	--		--	--	•
	3- & 4-Methylphenol	HLA-0063				--	•
	3-Methylcholanthrene	56-49-5	•		--	--	--
	Acetophenone	98-86-2	•		--	--	•
	Aramite	140-57-8	•		--	--	--
	Benzoic acid	65-85-0	•		•	--	•
	Benzyl alcohol	100-51-6	•		--	--	•
	Bis(2-chloroethoxy) methane	111-91-1	--		--	--	•
	Bis(2-chloroethyl) ether	111-44-4	--		--	•	•

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
	Bis(2-ethylhexyl) phthalate	117-81-7	•		•	•	•
	Butyl benzyl phthalate	85-68-7	•		--	--	•
	cyclic octaatomic sulfur	010544-50-0	•				
	Dibenzofuran	132-64-9	•		•	--	•
	Diethyl phthalate	84-66-2	•		•	--	•
	Dimethyl phthalate	131-11-3	•		--	--	•
	Di-n-butyl phthalate	84-74-2	•		•	--	•
	Di-n-octyl phthalate	117-84-0	•		--	--	--
	Ethyl methanesulfonate	62-50-0	•		--	--	--
	Eucalyptol	470-82-6	•				
	Hexachlorobenzene	118-74-1	•		•	--	•
	Hexachlorobutadiene	87-68-3	•	--	--	•	•
	Hexachloroethane	67-72-1	--		--	--	•
	Hexachlorophene	70-30-4	•			--	--
	Indeno(1,2,3-cd)pyrene	1888-71-7	--		--	•	--
	Isodrin	465-73-6	•		--	--	--
	Isophorone	78-59-1	•		--	--	•
	m-Cresol	108-39-4	•		--	--	
	N-Nitrosodiethylamine	55-18-5	•		--	•	•
	N-Nitrosodimethylamine	62-75-9	•		--	•	•
	N-Nitrosodipropylamine	621-64-7	•		--	•	•
	N-Nitrosomethylethylamine	10595-95-6	•		--	--	•
	N-Nitrosomorpholine	59-89-2	--		--	--	•
	N-Nitrosopiperidine	100-75-4	•		--	--	--
	N-Nitrosopyrrolidine	930-55-2	•		--	•	•
	o-Cresol	95-48-7	•		--	--	•
	o-Nitroaniline	88-74-4	•		--	--	--
	o-Nitrophenol	88-75-5	--		--	--	•
	p-Chloraniline	106-47-8	•		--	--	--
	p-Chloro-m-cresol	59-50-7	--		--	--	•
	PCNB (pentachloronitrobenzene)	82-68-8	•		--	--	•
	p-Cresol	106-44-5	•		--	--	
	Pentachlorobenzene	608-93-5	•		--	--	--
	Pentachlorophenol	87-86-5	•		--	--	•

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
	Phenanthrene	85-01-8	•		•	--	•
	Phenol	108-95-2	•		--	--	•
	p-Nitrophenol	100-02-7	•		--	--	•
	p-Phenylenediamine	106-50-3	•		--	--	--
Polycyclic Aromatic Hydrocarbons							
	2-Methylnaphthalene	91-57-6	•		•	--	•
	Acenaphthene	83-32-9	•		•	--	•
	Acenaphthylene	208-96-8	•		•	•	•
	Anthracene	120-12-7	•		•	--	--
	Benzo(a)anthracene	56-55-3	•		•	•	•
	Benzo(a)pyrene	50-32-8	•		•	•	•
	Benzo(b)fluoranthene	205-99-2	•		•	•	•
	Benzo(ghi)perylene	191-24-2	•		•	•	•
	Benzo(k)fluoranthene	207-08-9	•		•	--	•
	Chrysene	218-01-9	•		•	•	•
	Dibenz(a.h)anthracene	53-70-3	•		•	•	•
	Fluoranthene	206-44-0	•		•	--	•
	Fluorene	86-73-7	•		•	--	•
	Indeno (1,2,3-c,d) pyrene	193-39-5	•		•	--	•
	Naphthalene	91-20-3	•		•	•	•
	Pyrene	129-00-0	•		•	--	•
Organochlorine Pesticides / PCBs							
	4,4'-DDD	72-54-8	•		•	--	•
	4,4'-DDE	72-55-9	•		•	--	•
	4,4'-DDT	50-29-3	•		•	--	•
	Aldrin	309-00-2	•		•	--	•
	alpha-BHC	319-84-6	•		•	--	•
	beta-BHC	319-85-7	•		•	--	•
	Chlordane, alpha	5103-71-9	•		•	--	•
	Chlordane, gamma	12789-03-6	•		•	--	
	delta-BHC	319-86-8	•		•	--	•
	Dieldrin	60-57-1	•		•	--	--
	Endosulfan I	959-98-8	•		•	--	--
	Endosulfan II	33213-65-9	•		•	--	•

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
	Endosulfan sulfate	1031-07-8	•		•	--	•
	Endrin	72-20-8	•		•	--	•
	Endrin aldehyde	7421-93-4	•		•	--	•
	Endrin ketone	53494-70-5	•		•	--	--
	gamma-BCH (Lindane)	58-89-9	•		•	--	•
	gamma-Chlordane	5566-34-7				--	•
	Heptachlor	76-44-8	•		•	--	•
	Heptachlor epoxide	1024-57-3	•		•	--	•
	Kepone	143-50-0	•		•	--	•
	Methoxychlor	72-43-5	•		•	--	--
	Mirex	2385-85-5	•		•	--	--
	PCB - Arochlor 1016	12674-11-2	•		--	--	•
	PCB- Arochlor 1248	12672-29-6	•		•	--	--
	PCB- Arochlor 1254	11097-69-1	•		--	--	--
	PCB- Arochlor 1260	11096-82-5	•		•	--	--
	Total PCB's (Summation)	1336-36-3				--	•
Organophosphorous Pesticides							
	Chlorpyrifos	2921-88-2	--		--		•
	Diazinon	333-41-5	--		--		•
	Dimethoate	60-51-5	•		--	--	•
	Disulfoton	298-04-4	--		--	--	•
	EPN (Phosphonothioic acid)	2104-64-5	--		--	--	•
	Famphur	52-85-7	--		--	--	•
	Malathion	121-75-5	•		--	--	•
	Methyl parathion	298-00-0	--		--	--	•
	O,O,O-Triethyl phosphorothioate	126-68-1	--		--	--	•
	O,O-Diethyl O-2-pyrazinyl phosphorothioa	297-97-2	•		--	--	•
	Parathion	56-38-2	•		--	--	•
	Phorate	298-02-2	--		--	--	•
	Phosmet	732-11-6	•		--	--	•
	Tetraethyl dithiopyrophosphate (Sulfotep	3689-24-5	•		--	--	•
Chlorinated Herbicides							
	2,4,5-T	93-76-5	•		--	--	•
	2,4,5-TP;Silvex	93-72-1	•		--	--	•

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
	2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	•		--	--	•
	2,4-Dichlorophenoxybutyric acid (2,4-DB)	94-82-6	•		•	--	•
	2-sec-Butyl-4,6-dinitrophenol (Dinoseb)	88-85-7	•		--	--	--
	Dalapon	75-99-0	•		--	--	•
	Dicamba	1918-00-9	•		--	--	•
	Dichloroprop	120-36-5	•		•	--	•
	MCPA	94-74-6	•		--	--	•
	MCPP	7085-19-0 / 93-6	•		•	--	•
	Picloram	1918-02-1	•		--	--	•
Dioxin / Furans							
	1,2,3,4,6,7,8-HpCDD	35822-46-9	•		•	•	•
	1,2,3,4,6,7,8-HpCDF	67562-39-4	•		•	•	•
	1,2,3,4,7,8,9-HpCDF	55673-89-7	•		•	--	•
	1,2,3,4,7,8-HxCDD	39227-28-6	•		•	•	•
	1,2,3,4,7,8-HxCDF	70648-26-9	•		•	•	•
	1,2,3,6,7,8-HxCDD	57653-85-7	•		•	•	•
	1,2,3,6,7,8-HxCDF	57117-44-9	•		•	•	•
	1,2,3,7,8,9-HxCDD	19408-74-3	•		•	•	•
	1,2,3,7,8,9-HxCDF	72918-21-9	•		•	•	•
	1,2,3,7,8-PeCDD	40321-76-4	•		•	•	•
	1,2,3,7,8-PeCDF	57117-41-6	•		•	--	•
	2,3,4,6,7,8-HxCDF	60851-34-5	•		•	--	•
	2,3,4,7,8-PeCDF	57117-31-4	•		•	--	•
	2,3,7,8-TCDD	1746-01-6	•		•	--	•
	2,3,7,8-TCDF	51207-31-9	•		•	--	•
	OCDD	3268-87-9	•		•	•	•
	OCDF	39001-02-0	•		•	•	•
	TCDF (total)	30402-14-3				--	•
	Total Avian Dioxin TEQ*	URS-TEQ-04	•		•	•	
	Total Fish Dioxin TEQ*	URS-TEQ-06	•		•	•	
	Total HpCDD	37871-00-4	•		•	--	•
	Total HpCDF	38998-75-3	•		•	--	•
	Total HxCDD	34465-46-8	•		•	--	•
	Total HxCDF	55684-94-1	•		•	--	•

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
	Total PeCDD	36088-22-9	•		•	--	•
	Total PeCDF	30402-15-4	•		•	--	•
	Total TCDD	41903-57-5	•		•	--	•
	Total TCDF	55722-27-5	•		•		
	Total TEQ*	URS-TEQ-02	•		•	•	
PCB Congeners							
	2,2',3,4,4',5,5'-HpCB-180	35065-29-3	•		•		
	2,2'3,3'4,4',5-HpCB-170	35065-30-6	•		•		
	2,3,3',4,4',5,5'-HpCB-189	39635-31-9	•		•		
	2,3,3',4,4',5-HxCB-156	38380-08-4	•		•		
	2,3,3',4,4',5'-HxCB-157	69782-90-7	•		•		
	2,3,3',4,4'-PeCB-105	32598-14-4	•		•		
	2,3',4,4',5,5'-HxCB-167	52663-72-6	•		•		
	2,3,4,4',5-PeCB-114	74472-37-0	•		•		
	2,3',4,4',5-PeCB-118	31508-00-6	•		•		
	2',3,4,4',5-PeCB-123	65510-44-3	•		•		
	3,3',4,4',5,5'-HxCB-169	32774-16-6	•		•		
	3,3',4,4',5-PeCB-126	57465-28-8	•		•		
	3,3',4,4'-TeCB-77	32598-13-3	•		•		
	3,4,4',5-TeCB-81	70362-50-4	•		•		
	PCBC TEQ*	URS-TEQ-03	•		•		
	Total Avian PCBC TEQ*	URS-TEQ-05	•		•		
	Total Deca-PCB	URS-700-001	•		•		
	Total Di-PCBs	25512-42-9	•		--		
	Total Fish PCBC TEQ*	URS-TEQ-07	•		•		
	Total Hepta-PCBs	28655-71-2	•		•		
	Total Hexa-PCBs	26601-64-9	•		•		
	Total Nona-PCBs	53742-07-7	•		•		
	Total Octa-PCBs	31472-83-0	•		•		
	Total PCB Congeners*	URS-SUM-PCBC	•		•		
	Total Penta-PCBs	25429-29-2	•		•		
	Total Tetra-PCBs	26914-33-0	•		•		
	Total Tri-PCBs	25323-68-6	•		•		

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	ANALYTE	CAS RN	SOIL	SOIL VAPOR	SEDIMENT	SURFACE WATER	GROUNDWATER
Perchlorate							
	Perchlorate	14797-73-0					•
Nitroamine							
	HMX	2691-41-0					•
	RDX	121-82-4					•
	Tetryl	479-45-8					•
Nitrotoluene							
	2-Amino-4,6-DNT	35572-78-2					•
	2-Nitrotoluene	88-72-2					•
pCBSA							
	p-CBSA	HLA-0001					•
Poor-Purge Organics							
	1,4-Dioxane	123-91-1	•	•	--	--	•
	1-Butanol	71-36-3	•		--	--	•
	1-Propanol	71-23-8	--		--	--	•
	2-Pentanone	107-87-9	•		--	--	•
	2-Picoline	109-06-8	--		--	--	•
	2-Propanol (Isopropyl)	67-63-0	•	•	--	--	•
	4-Methyl-2-pentanone	108-10-1	•	•	•	•	•
	Acetone	67-64-1	•	•	•	•	•
	Acetonitrile	75-05-8	•		--	•	•
	Acrolein	107-02-8	•		--	--	•
	Acrylonitrile	107-13-1	--		--	--	•
	Allyl alcohol	107-18-6	--			--	•
	Crotonaldehyde	123-73-9	--			--	•
	Diethyl ether	60-29-7	•		--	--	•
	Ethanol	64-17-5	•	•	--	--	•
	Ethyl acetate	141-78-6	•			--	--
	Ethylene glycol	107-21-1	•			--	•
	Ethylene oxide	75-21-8	--			--	•
	Isobutyl alcohol	78-83-1	•		--	--	•
	Methanol	67-56-1	•			--	•
	Methyl ethyl ketone	78-93-3	•	•	•	--	•
	N-Nitrosodi-n-butylamine	924-16-3	•		--	--	•

TABLE 5-2

SUMMARY OF CHEMICALS DETECTED IN MEDIA
REMEDIAL INVESTIGATION SAMPLING PROGRAM

DETECTED CHEMICALS			MEDIA WHERE DETECTED				
CHEMICAL GROUP	**ANALYTE**	**CAS RN**	**SOIL**	**SOIL VAPOR**	**SEDIMENT**	**SURFACE WATER**	**GROUNDWATER**
	o-Toludine	95-53-4	--		--	--	•
	Paraldehyde	123-63-7	--		--	--	•
	Propionitrile	107-12-0	--		--	--	•
	Pyridine	110-86-1	•		--	--	•
	t-Butanol	75-65-0	•		--	--	•
Total Petroleum Hydrocarbons							
	Diesel Range Organics (C12 - C24)	TPHCD				•	•
	TPH as Diesel	68334-30-5	•				
	TPH as Gasoline	86290-81-5	•				
	TPH as Motor Oil	TPHMO / URS-OI	•			•	•

Notes:

--	Chemical not detected in listed media
•	Chemical detected in listed media
◦	Chemical detected in listed media, but at concentration(s) below background level.
*	Calculated value

Background levels are referenced to Upper Threshold Limit (UTLs) calculated from RI dataset, and are limited to inorganic constituents
Blank cells indicate analyte was not tested

TABLE 5-3

SUMMARY OF RISK-BASED CONCENTRATION EXCEEDANCES BY MEDIA, LOCATION, AND CONSTITUENT

MEDIA	STUDY AREA	CONSTITUENT(S)	EXCEEDANCES
Soil	Capped Landfills Area	None	No unacceptable exposures
	RCRA Canyon	Chromium; Copper; Zinc	Eco RBC Exceedance
	West Canyon Spray Area	Chromium; Copper; Zinc	Eco RBC Exceedance
	Burial Trench Area	Total DDT; Dioxin TEQ; TCE; Copper	Eco RBC Exceedance
	Central Drainage Area	Dioxin TEQ	HH RBC exceedance (One location)
		Total DDT; TCE; Dioxin TEQ; Chromium	Eco RBC Exceedance
	Liquids Treatment	MCPP	HH RBC Exceedance (One Location)
		Total DDT; MCPP; Chromium; Copper; Zinc	Eco RBC Exceedance
	Maintenance Shed Area	Dioxin TEQ	HH RBC Exceedance (One location)
		Total DDT; Dioxin TEQ; Chromium; Copper; Zinc	Eco RBC Exceedance
	Administration Buliding Area	None	No unacceptable exposures
	Roadways Area	Total DDT; PCB Congeners; Chromium; Copper; Zinc	Eco RBC Exceedance
	Former Ponds & Pads and Remaining Onsite Areas	PCE	HH RBC exceedance (One location)
		Total DDT; PCE; TCE; Total PCB congeners; Chromium; Copper	Eco RBC Exceedance
	Off-Site Soils	None	No unacceptable exposures

TABLE 5-3

SUMMARY OF RISK-BASED CONCENTRATION EXCEEDANCES BY MEDIA, LOCATION, AND CONSTITUENT

MEDIA	STUDY AREA	CONSTITUENT(S)	EXCEEDANCES
Sediment	Stormwater Ponds	MCPP	Eco RBC Exceedance
	Treated Liquids Impoundments	MCPP	Eco RBC exceedance
	Off-site Sediments	None	No unacceptable exposures
Soil Vapor	Central Drainage Area	PCE	No unacceptable exposures
	Former Ponds & Pads	PCE, TCE	No unacceptable exposures
	Burial Trench Area	TCE	No unacceptable exposures
	North Drainage	1,3-Butadiene	HHRA Exceeedance - Offsite resident (hypothetical)
Surface Water (On-site Ponds)	Stormwater Ponds	Arsenic	HHRA Exceedance - Industrial workers
		Arsenic; Barium; Nickel; Selenuim	Eco Exceedance - Aquatic plants, aquatic life
	Treated Liquids Impondments	None	No unacceptable exposures
Surface Water (On-site drainages)	On-site	None	No unacceptable exposures
Surface-Water (Off-site drainages)	Off-site	None	No unacceptable exposures
Groundwater	On/Off-site	None	No unacceptable exposures

NOTES:

Eco RBC Exceedance - Listed constituents exceed site specific ecological risk-based concentration. See Section 9 and Appendix U for details of ecological risk assessment findings.

HH RBC Exceedance - Listed constituents exceed site-specific human health risk-based concentrations. See Section 8 and Appendix T for details of the human health risk assessment findings.

HHRA Exceedance - Chemical was identified as a risk-driver in the HHRA (see Appendix T)

Eco Exceedance - Chemical was identified as a risk-driver in the ERA (see Appendix U)

It should be noted that while there may be a few individual samples in a Study Area that exceed a RBC, the Study Area as a whole may not pose a significant risk due to the use of the 95UCL concentration in the ERA and HHRA. The 95UCL concentration better represents the concentration a receptor may be exposed to on a regular basis. The sample-specific comparison to the RBCs presented in this section is to only provide context to the discussion of nature and extent of constituents across the Site.

TABLE 5-4
RANGE OF INORGANIC CONSTITUENTS IN SURFACE WATER DRAINAGE SAMPLES

		A Drainage		North Drainage		Upper C Drainage		Lower C Drainage		RCRA Canyon	
Parameter	**Units**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**	**Total**	**Dissolved**
Aluminum	µg/l	4100-4100	330-330	ND-150000	ND-6700	820-100000	ND-4800	690-92000	ND-1100	ND-3900	ND
Antimony	µg/l	ND	ND	ND-150	ND-0.63	0.49-44	ND	0.48-40	ND-0.42	0.4-130	ND-0.93
Arsenic	µg/l	2.3-2.3	1.8-1.8	5.8-47	8-23	1.8-19	3.3-6.4	2.5-18	3.7-9	48-180	86-270
Barium	µg/l	35-35	23-23	50-1100	41-100	60-640	51-55	40-540	25-48	29-190	24-24
Beryllium	µg/l	0.1-0.1	0.03-0.03	ND-9	ND-1.6	0.039-4.7	ND-0.05	0.033-4.3	ND-0.02	ND-0.19	ND-0.051
Cadmium	µg/l	0.23-0.23	0.1-0.1	ND-13	ND-4.2	0.14-6.1	ND-0.15	ND-4.9	ND-0.18	0.92-4.7	0.34-5.6
Calcium	mg/l	18-18	19-19	81-740	10-720	55-180	21-180	60-180	35-170	320-460	370-440
Chromium	µg/l	ND	ND	ND-380	5-10	4-240	ND-2.1	2.2-240	ND-1.8	ND-26	5-7.8
Cobalt	µg/l	ND	ND	ND-63	ND-11	ND	ND-0.9	ND-13	ND-1.3	ND	ND
Copper	µg/l	32-32	ND	ND-160	ND-7	ND-110	ND	ND-110	ND-1	ND-44	ND-8.5
Iron	µg/l	4000-4000	950-950	ND-220000	36-3800	1100-130000	4.9-800	1100-110000	ND-720	ND-5000	ND
Lead	µg/l	0.86-0.86	0.15-0.15	ND-63	0.054-20	0.42-34	ND-0.32	0.32-33	ND-0.58	ND-1.7	ND-0.81
Magnesium	mg/l	11-11	12-12	87-710	7.7-720	43-84	13-88	43-90	21-87	240-470	280-400
Manganese	µg/l	31-31	ND	150-2000	42-1400	31-650	11-23	60-710	12-140	39-160	ND-95
Mercury	µg/l	ND	ND	ND-0.23	ND-0.05	ND-0.12	ND	ND-0.11	ND	ND-0.14	0.1-0.14
Molybdenum	µg/l	ND	14-14	ND-77	ND-68	ND-22	ND-22	ND-27	17-30	35-86	31-58
Nickel	µg/l	13-13	6.3-6.3	ND-440	17-35	4.2-230	1.5-18	2.3-230	1.5-22	67-160	74-100
Potassium	mg/l	4.2-4.2	3.2-3.2	11-56	2.2-53	4.3-18	4.3-4.6	5.1-19	4.5-14	11-22	11-15
Selenium	µg/l	1.7-1.7	1-1	6-96	0.71-120	0.46-4.3	2.3-5.8	1.2-5.7	3.2-6.2	200-740	350-1000
Silver	µg/l	ND	ND	ND-0.53	ND-1	ND-0.53	ND	ND-0.48	ND-0.02	ND-0.065	ND-0.075
Sodium	mg/l	31-31	35-35	100-2100	85-2200	66-120	70-120	81-150	87-150	560-1100	630-890
Thallium	µg/l	ND	ND	ND-2.8	ND-1	ND-1.6	ND-0.23	ND-1.5	ND-0.31	0.098-0.14	ND-0.18
Tin	µg/l	ND	ND	ND-4.4	ND-1.4	ND-3.2	ND	ND-2.9	ND	ND-0.33	ND
Vanadium	µg/l	ND	ND	36-310	ND-160	35-230	ND-40	36-200	ND-40	ND-70	47-80
Zinc	µg/l	10-10	3.8-3.8	10-470	9.9-170	4.7-280	ND-8.2	5.5-250	ND-7.6	12-33.7	7.8-20

Footnotes:
µg/l = micrograms per liter
mg/l = milligrams per liter
ND = Parameter was not detected at or above the method detection limit

TABLE 5-5
RANGE OF DETECTED ORGANIC CONSTITUENTS IN SURFACE WATER DRAINAGE SAMPLES

Parameter	Units	A Drainage	Lower C Drainage	North Drainage	RCRA Canyon	Upper C Drainage
Dioxins						
1,2,3,4,6,7,8-HpCDD	pg/l	ND	6.54-202	6.91-57.9	ND-5.12	8.59-278
1,2,3,4,6,7,8-HpCDF	pg/l	ND	ND-11.6	ND-7.56	ND	ND
1,2,3,4,7,8-HxCDD	pg/l	ND	ND-6.11	ND-0.666	ND	ND-7.53
1,2,3,4,7,8-HxCDF	pg/l	ND	ND	ND-2.06	ND	ND
1,2,3,6,7,8-HxCDD	pg/l	ND	ND-21.2	ND-20.1	ND	ND-26.9
1,2,3,6,7,8-HxCDF	pg/l	ND	ND-3.66	ND-3.21	ND	ND
1,2,3,7,8,9-HxCDD	pg/l	ND	ND-25.4	ND-24.6	ND	ND-30.5
1,2,3,7,8,9-HxCDF	pg/l	ND	ND-10	ND-6.59	ND	ND-10.8
1,2,3,7,8-PeCDD	pg/l	ND	ND	ND-2.45	ND	ND
OCDD	pg/l	18.4-18.4	145-6930	135-1020	15.6-35.6	203-9650
OCDF	pg/l	ND	ND-14.9	ND-12	ND	ND
Total TEQ	pg/l	0.00552-0.00552	0.1089-10.4971	0.1096-9.067977	0.00468-0.06188	0.1468-13.248
Poor Purging Organics						
Acetone	µg/l	ND	ND-1100	ND-320	ND	ND
Acetonitrile	µg/l	ND	ND-3700	ND	ND	ND
Ethylene glycol	µg/l	4100-4100	4600-6400	4000-4000	3800-3800	5300-5300
Methyl isobutyl ketone (MIBK)	µg/l	ND	ND	ND-490	ND	ND
Semi Volatile Organic Compounds						
Benzo(a)anthracene	µg/l	ND	ND-0.011	ND-0.011	ND	ND-0.01
Benzo(a)pyrene	µg/l	ND	ND	ND-0.016	ND	ND
Benzo(b)fluoranthene	µg/l	ND	ND	ND-0.057	ND-0.054	ND
Benzo(g,h,i)perylene	µg/l	ND	ND	ND-0.016	ND	ND
Bis(2-chloroethyl)ether	µg/l	ND	ND-0.016	ND-0.092	ND-0.089	ND
Bis(2-ethylhexyl)phthalate	µg/l	ND	ND-1.3	ND-1.6	ND	ND
Chrysene	µg/l	ND	ND	ND-0.011	ND	ND
Dibenzo(a,h)anthracene	µg/l	ND	ND	ND-0.022	ND	ND
Hexachlorobutadiene	µg/l	ND	ND	ND	ND-0.44	ND
Hexachloropropene	µg/l	ND	ND	ND-0.019	ND	ND
Naphthalene	µg/l	0.03-0.03	ND	ND	ND	ND
N-Nitrosodiethylamine	µg/l	ND	ND	ND-0.067	ND	ND
N-Nitrosodipropylamine	µg/l	0.05-0.05	ND-0.1	ND-0.086	0.05-0.053	ND-0.068
N-Nitrosopyrrolidine	µg/l	ND	ND	ND-0.094	ND-0.09	ND
Volatile Organic Compounds						
Carbon disulfide	µg/l	ND	ND-0.59	ND	ND	ND
Nonanal	µg/l	ND	ND	ND-0.91	ND-1.4	ND
p-Isopropyltoluene	µg/l	ND	ND	ND-0.29	ND	ND

Footnotes:
µg/l = micrograms per liter
mg/l = milligrams per liter
pg/l = picograms per liter
ND = Parameter was not detected at or above the method detection limit

TABLE 5-6
SUMMARY OF INORGANIC ANALYTICAL RESULTS FOR SURFACE WATER POND SAMPLES

		A-Series Pond		Pond 13		Pond 18		Pond A-5		RCF Pond	
Parameter	**Units**	**11/3/2004**	**4/8/2005**	**10/28/2004**	**4/7/2005**	**11/4/2004**	**4/12/2005**	**11/3/2004**	**4/8/2005**	**10/28/2004**	**4/7/2005**
Aluminum-T	µg/l	ND(250.) /UD	330. /D	ND(250.) /UD	ND(250.) /UD	ND(250.) /UD	ND(250.) /UD	ND(500.) /UD	320. /D	ND(250.) /UD	ND(250.) /UD
Antimony-D	µg/l	ND(10.) /UD	1.0 /J	ND(10.) /UD	ND(10.) /UD	ND(10.) /UD	0.25 /J	ND(10.) /UD	1.1 /J	ND(10.) /UD	ND(10.) /UD
Antimony-T	µg/l	ND(10.) /UD	0.48 /J	ND(20.) /UD	ND(10.) /UD	4.8 /JD	0.43 /J	ND(20.) /UD	0.45 /J	ND(20.) /UD	ND(10.) /UD
Arsenic-D	µg/l	**190. /D**	**290.**	**710. J+/D**	**200. /D**	**78. /D**	**78.**	**250. /D**	**220.**	**400. J+/D**	**110. /D**
Arsenic-T	µg/l	**210. /D**	**110.**	**310. /DB**	**150. /D**	**99. /D**	**11.**	**330. /D**	**120.**	**190. /DB**	**97. /D**
Barium-D	µg/l	67. /D	140. /D	150. /D	78. /D	ND(44.) U*/JD	120. /D	87. /JD	150. /D	43. /JD	190. /D
Barium-T	µg/l	41. /JD	18. /JD	17. /JD	56. /D	18. /JD	39. /JD	48. /JD	17. /JD	ND(50.) /UD	41. /JD
Beryllium-D	µg/l	ND(5.0) /UD	0.019 /J	0.44 J-/JD	ND(5.0) /UD	0.16 J-*/JD	ND(1.0) /U	0.35 /JD	ND(1.0) /U	0.095 J-/JD	ND(5.0) /UD
Beryllium-T	µg/l	0.51 /JD	ND(1.0) /U	0.23 /JD	ND(5.0) /UD	0.68 /JD	ND(1.0) /U	1.4 /JD	ND(1.0) /U	ND(10.) /UD	ND(5.0) /UD
Cadmium-D	µg/l	ND(5.0) /UD	0.20 /JB	ND(5.0) /UDB	ND(5.0) /UD	ND(5.0) /UD	0.42 /J	ND(5.0) /UD	ND(1.0) /UB	ND(2.0) U/JDB	ND(5.0) /UD
Cadmium-T	µg/l	ND(5.0) /UD	ND(1.0) /U	ND(10.) /UD	ND(5.0) /UD	ND(2.2) U*/JDB	1.1	3.5 /JD	0.15 /J	ND(10.) /UD	ND(5.0) /UD
Calcium-D	mg/l	1,100. /D	780. /D	1,200. /DB	620. /D	990. /D	520. /D	950. /D	560. /D	1,100. /DB	470. /D
Calcium-T	mg/l	1,200. /D	790. /D	130. /D	630. /D	1,000. /D	490. /DB	870. /D	590. /D	110. /D	490. /D
Chromium-D	µg/l	30. /JD	ND(50.) /UD	**92. /D**	ND(50.) /UD	40. /JD	ND(50.) /UD	**97. /JD**	ND(50.) /UD	**60. /D**	ND(50.) /UD
Chromium-T	µg/l	32. /JD	20. /JD	ND(50.) /UD	16. /JD	41. /JD	ND(50.) /UD	**89. /JD**	32. /JD	ND(50.) /UD	ND(50.) /UD
Copper-D	µg/l	6.1 /JD	ND(50.) /UD	ND(50.) /UD	ND(50.) /UD	10. /JD	ND(50.) /UD	21. /JD	ND(50.) /UD	ND(50.) /UD	ND(50.) /UD
Copper-T	µg/l	ND(50.) /UD	30. /JD	ND(50.) /UD	24. /JD	ND(50.) /UD	31. /JD	ND(100.) /UD	29. /JD	ND(50.) /UD	19. /JD
Cyanide (Free)	mg/l	ND(0.012) /U	ND(0.02) /U	ND(0.012) /U	ND(0.02) /U	ND(0.012) /U	0.0075 /J	ND(0.012) /U	ND(0.02) /U	ND(0.012) /U	ND(0.02) /U
Iron-D	µg/l	27. /JD	ND(250.) /UD	40. /JD	ND(250.) /UD	35. /JD	ND(250.) /UD	ND(500.) /UD	ND(250.) /UD	ND(250.) /UD	ND(250.) /UD
Iron-T	µg/l	ND(250.) /UD	ND(250.) /UD	ND(500.) /UD	ND(250.) /UD	130. /JD	ND(250.) /UD	310. J/JD	87. /JD	ND(500.) /UD	ND(250.) /UD
Lead-D	µg/l	ND(5.0) /UD	ND(1.0) /U	ND(5.0) /UD	ND(5.0) /UD	ND(5.0) /UD	0.12 /J	ND(5.0) /UD	ND(1.0) /U	ND(5.0) /UD	9.6 /D
Lead-T	µg/l	ND(5.0) /UD	0.19 /J	ND(10.) /UD	ND(5.0) /UD	0.18 /JD	0.34 /J	ND(10.) /UD	0.21 /J	ND(10.) /UD	ND(5.0) /UD

Footnotes:
D - dissolved
T - total
µg/l - micrograms per liter
mg/l - milligrams per liter
ND - not detected
NT - not tested
N - The anlysis indicates the presence of an anlyte for which there is presumptive evidence to make a tentative identification
Bold values indicate exceedances of one or more screening levels.
Qualifiers are listed as validation qualifier / lab qualifier where applicable (e.g.B/R)

Laboratory Assigned Qualifiers

B - Compound is also detected in the laboratory method
U - Compound was analyzed for but not detected.
D - Compound is identified in an analysis at a secondary
J - Result is detected below the reporting limit or is an

MACTEC Validation Assigned Qualifiers

J - Data are qualified as estimated. It is not possible to assess the direction of the potential bias. False positives or false negatives are unlikely to have been reported.
J- -Data are qualified as estimated, with a low bias likely to occur. False positives or false negatives are unlikely to have been reported.
J+ - Data are qualified as estimated, with a high bias likely to occur. False positives or false negatives are unlikely to have been reported.
U - Data are qualified as nondetected, because the analyte was observed in an associated laboratory or field blank.
Where validation qualifiers are absent, data was used for screening purposes only

TABLE 5-6
SUMMARY OF INORGANIC ANALYTICAL RESULTS FOR SURFACE WATER POND SAMPLES

		A-Series Pond		Pond 13		Pond 18		Pond A-5		RCF Pond	
Parameter	**Units**	**11/3/2004**	**4/8/2005**	**10/28/2004**	**4/7/2005**	**11/4/2004**	**4/12/2005**	**11/3/2004**	**4/8/2005**	**10/28/2004**	**4/7/2005**
Magnesium-D	mg/l	1,200. /D	790. /D	2,500. /D	640. /D	1,500. /D	540. /D	3,300. /D	1,300. /D	1,600. /D	440. /D
Magnesium-T	mg/l	1,200. /D	730. /D	250. /D	640. /D	1,600. /DB	510. /D	3,200. /D	1,300. /D	150. /D	460. /D
Manganese-D	µg/l	27. /JD	530. /D	ND(50.) /UD	490. /D	290. /D	110. /D	ND(100.) /UD	**2,000. /D**	ND(50.) /UD	170. /D
Manganese-T	µg/l	320. /D	160. /D	ND(50.) /UD	530. /D	330. /D	72. /D	**2,700. /D**	**2,500. /D**	ND(50.) /UD	160. /D
Mercury-D	µg/l	0.16 /J	0.21	0.13 J-/J	0.078 /J	0.17 /J	ND(0.20) /U	0.09 /J	0.092 /J	0.058 J-/J	ND(0.20) /U
Mercury-T	µg/l	NT	0.12 /J	0.12 J-/J	ND(0.20) /U	0.14 /J	0.062 /J	NT	0.16 /J	0.11 J-/J	ND(0.20) /U
Molybdenum-D	µg/l	42. /JD	40. /JD	38. /JD	43. /JD	55. /JD	39. /JD	63. /JD	51. /JD	35. /JD	47. /JD
Molybdenum-T	µg/l	44. /JD	38. /JD	ND(250.) /UD	38. /JD	55. /JD	41. /JD	ND(500.) /UD	48. /JD	ND(250.) /UD	38. /JD
Nickel-D	µg/l	**440. /D**	**300. /D**	**2,000. /D**	**410. /D**	**330. /D**	**160. /D**	**540. /D**	**180. /D**	**460. /D**	**120. /D**
Nickel-T	µg/l	**440. /D**	**280. /D**	**210. /D**	**430. /D**	**340. /D**	**160. /D**	**550. /D**	**220. /D**	39. /JD	**120. /D**
Potassium-D	mg/l	53. /D	37. /D	62. /D	17. /D	89. /D	40. /D	170. /D	66. /D	64. /D	23. /D
Potassium-T	mg/l	53. /D	33. /D	6.7 /D	16. /D	92. /D	38. /D	170. /D	65. /D	6.0 /D	23. /D
Selenium-D	µg/l	**690. /D**	**820.**	**2,900. J+/D**	**720. /D**	**300. /D**	**320.**	**940. /D**	**660.**	**1,600. J+/D**	**380. /D**
Selenium-T	µg/l	**900. /D**	**430.**	**1,600. /D**	**610. /D**	**430. /D**	**55.**	**1,400. /D**	**460.**	**970. /D**	**390. /D**
Silver-D	µg/l	ND(5.0) UJ/UD	ND(1.0) /U	ND(5.0) UJ/UD	ND(5.0) /UD	0.42 J-*/JD	ND(1.0) /U	ND(5.0) UJ/UD	ND(1.0) /U	ND(5.0) UJ/UD	ND(5.0) /UD
Silver-T	µg/l	ND(5.0) /UD	ND(1.0) /U	0.27 /JD	ND(5.0) /UD	0.24 /JD	0.05 /J	0.57 /JD	ND(1.0) /U	ND(10.) /UD	ND(5.0) /UD
Sodium-D	mg/l	3,400. /D	2,100. /D	8,700. /D	2,300. /D	3,300. /D	1,200. /D	6,800. /D	2,400. /D	4,500. /D	1,300. /D
Sodium-T	mg/l	3,500. /D	2,000. /D	890. /D	2,300. /D	3,300. /D	1,200. /D	6,600. /D	2,600. /D	460. /D	1,300. /D
Thallium-D	µg/l	ND(5.0) /UD	ND(1.0) /U	ND(5.0) /UD	ND(5.0) /UD	0.93 /JD	0.15 /J	ND(5.0) /UD	ND(1.0) /U	ND(5.0) /UD	ND(5.0) /UD
Thallium-T	µg/l	ND(5.0) /UD	ND(1.0) /U	ND(10.) /UD	ND(5.0) /UD	**2.0 /JD**	0.28 /J	ND(10.) /UD	ND(1.0) /U	ND(10.) /UD	ND(5.0) /UD
Tin-T	µg/l	ND(5.0) /UD	ND(1.0) /U	ND(10.) /UD	ND(5.0) /UD	1.3 /JD	0.36 /J	ND(10.) /UD	ND(1.0) /U	ND(10.) /UD	ND(5.0) /UD
Vanadium-D	µg/l	**63. /D**	ND(50.) /UD	ND(50.) /UD	ND(50.) /UD	27. /JD	ND(50.) /UD	**54. /JD**	ND(50.) /UD	ND(50.) /UD	ND(50.) /UD
Vanadium-T	µg/l	**55. /D**	**110. /D**	**54. /D**	**120. /D**	26. /JD	13. /JD	**59. /JD**	**75. /D**	33. /JD	**97. /D**
Zinc-D	µg/l	98. /D	18.	30. /D	8.1 /JD	20. /JD	22.	79. /D	23.	18. /JD	45. /D
Zinc-T	µg/l	ND(25.) /UD	20.	38. J/JD	ND(25.) /UD	25. /D	24.	ND(50.) /UD	27.	69. J/D	ND(25.) /UD

Footnotes:
D - dissolved
T - total
µg/l - micrograms per liter
mg/l - milligrams per liter
ND - not detected
NT - not tested
N - The anlysis indicates the presence of an anlyte for which there is presumptive evidence to make a tentative identification
Bold values indicate exceedances of one or more screening levels.
Qualifiers are listed as validation qualifier / lab qualifier where applicable (e.g.B/R)

Laboratory Assigned Qualifiers

B - Compound is also detected in the laboratory method
U - Compound was analyzed for but not detected.
D - Compound is identified in an analysis at a secondary
J - Result is detected below the reporting limit or is an

MACTEC Validation Assigned Qualifiers

J - Data are qualified as estimated. It is not possible to assess the direction of the potential bias. False positives or false negatives are unlikely to have been reported.
J- -Data are qualified as estimated, with a low bias likely to occur. False positives or false negatives are unlikely to have been reported.
J+ - Data are qualified as estimated, with a high bias likely to occur. False positives or false negatives are unlikely to have been reported.
U - Data are qualified as nondetected, because the analyte was observed in an associated laboratory or field blank.
Where validation qualifiers are absent, data was used for screening purposes only

TABLE 5-7
SUMMARY OF DETECTED ORGANIC ANALYTICAL RESULTS FOR SURFACE WATER POND SAMPLES

		A-Series Pond		Pond 13		Pond 18		Pond A-5		RCF Pond	
Parameter	**Units**	**11/3/2004**	**4/8/2005**	**10/28/2004**	**4/7/2005**	**11/4/2004**	**4/12/2005**	**11/3/2004**	**4/8/2005**	**10/28/2004**	**4/7/2005**
(E)-1-Chloro-1-propene	µg/l	NT	NT	NT	NT	NT	NT	NT	1.4 /NJ	NT	NT
1,1 Dichloroethane	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	0.44 /J	ND(0.50) /U	1.3	ND(0.50) /U	ND(0.50) /U
1,1 Dichloroethene	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	0.43 /J	ND(0.50) /U	ND(0.50) /U
1,1-Dichloro-1-fluoroethane	µg/l	NT	1.3 /NJ	NT	NT	NT	NT	NT	NT	NT	NT
1-Chloro-1-propene	µg/l	NT	NT	NT	NT	NT	NT	NT	1.5 /NJ	NT	NT
Acetaldehyde	µg/l	NT	NT	NT	NT	1.5 /N	NT	NT	NT	NT	NT
Acetone	µg/l	NT	NT	NT	NT	NT	NT	NT	18. /B	NT	NT
Benzene	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	0.15 /J	ND(0.50) /U	ND(0.50) /U
Carbon disulfide	µg/l	ND(1.0) /U	ND(1.0) /U	ND(1.0) /U	ND(1.0) /U	0.41 /J	ND(1.0) /U	ND(1.0) /U	ND(1.0) /U	ND(1.0) /U	ND(1.0) /U
Chloroform	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	0.40 /J	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U
Cis 1,2 Dichloroethene	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	0.24 /J	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U
Dimethyl sulfide	µg/l	0.67 /N	NT	2.9 /N	0.84 /NJ	1.4 /N	NT	NT	NT	0.79 /N	NT
Freon 113	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	3.1	ND(0.50) /U	ND(0.50) /U
Methyl Chloride	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	0.23 /J	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U
Methylene Chloride	µg/l	ND(1.0) /U	ND(1.0) /U	ND(1.0) /U	1.5	ND(9.1) U*	0.48 /J	ND(1.0) /U	ND(1.0) /U	ND(1.0) /U	**7.0**
Methyl-tert-butyl ether	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	**13.**	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U
Propanal	µg/l	ND(20.) /U	ND(20.) /U	ND(20.) /U	ND(20.) /U	14. /J	ND(20.) /U	12. /J	ND(20.) /U	ND(20.) /U	ND(20.) /U
Tetrahydrofuran	µg/l	ND(20.) /U	ND(20.) /U	ND(20.) /U	ND(20.) /U	ND(20.) /U	**3.8 /J**	ND(20.) /U	ND(20.) /U	ND(20.) /U	ND(20.) /U
Trichloroethene	µg/l	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	ND(0.50) /U	**1.2**	ND(0.50) /U	**1.3**	ND(0.50) /U	ND(0.50) /U
1,11-Dodecadiene	µg/l	NT	NT	NT	NT	NT	NT	19. /DN	NT	NT	NT
1,1-oxybis_2-Methoxy_ethane	µg/l	9.5 /N	NT	27. /N	NT	NT	NT	15. /DN	NT	NT	NT
1,2,3-Trimethylbenzene	µg/l	9.3 /N	NT	NT	NT	25.6 /N	NT	NT	NT	11. /N	NT
1,2,4 Trimethylbenzene	µg/l	NT	NT	**17. /N**	NT	NT	NT	NT	NT	NT	NT
1,3,5 Trimethylbenzene	µg/l	NT	NT	5.8 /N	NT	NT	NT	NT	NT	NT	NT

Footnotes:
µg/l - micrograms per liter
mg/l - miligrams per liter
pg/l - picograms per liter
ND - not detected
NT - not tested
N - The anlysis indicates the presence of an anlyte for which there is presumptive evidence to make a tentative identification
Bold values indicate exceedances of one or more screening levels.
Qualifiers are listed as validation qualifier / lab qualifier where applicable (e.g.B/R)

Laboratory Assigned Qualifiers

B - Compound is also detected in the laboratory method blank.
U - Compound was analyzed for but not detected.
D - Compound is identified in an analysis at a secondary dilution factor.
J - Result is detected below the reporting limit or is an estimated concentration.

MACTEC Validation Assigned Qualifiers

J - Data are qualified as estimated. It is not possible to assess the direction of the potential bias. False positives or false negatives are unlikely to have been reported.
J- -Data are qualified as estimated, with a low bias likely to occur. False positives or false negatives are unlikely to have been reported.
J+ - Data are qualified as estimated, with a high bias likely to occur. False positives or false negatives are unlikely to have been reported.
U - Data are qualified as nondetected, because the analyte was observed in an associated laboratory or field blank.
J* - Analytical results for this compound are qualified as estimated due to miscellaneous lab errors.
Where validation qualifiers are absent, data was used for screening purposes only

TABLE 5-7
SUMMARY OF DETECTED ORGANIC ANALYTICAL RESULTS FOR SURFACE WATER POND SAMPLES

		A-Series Pond		Pond 13		Pond 18		Pond A-5		RCF Pond	
Parameter	**Units**	**11/3/2004**	**4/8/2005**	**10/28/2004**	**4/7/2005**	**11/4/2004**	**4/12/2005**	**11/3/2004**	**4/8/2005**	**10/28/2004**	**4/7/2005**
1-Ethyl-2-methylbenzene	µg/l	NT	NT	8.3 /N	NT	6.0 /N	NT	NT	NT	NT	NT
2-Chlorocyclohexanol	µg/l	NT	NT	NT	NT	NT	NT	NT	NT	7.5 /N	NT
bis(2-Ethylhexyl) phthalate	µg/l	ND(5.0) /U	ND(5.0) /UB	ND(5.0) /U	**5.6 /B**	ND(5.0) /U	ND(25.) /UDB	ND(5.6) /UD	**51. /DB**	ND(5.0) /U	**5.0 /B**
n-Hexadecanoic acid	µg/l	NT	NT	8.5 /N	NT	NT	NT	13. /DN	NT	11. /N	NT
Tetradecanoic acid	µg/l	NT	NT	NT	NT	NT	NT	8.2 /DN	NT	NT	NT
Z-11-Hexadecanoic Acid	µg/l	NT	NT	NT	NT	NT	NT	15. /DN	NT	NT	NT
Acenaphthylene	µg/l	ND(0.10) /U	ND(0.10) /U	ND(0.10) UJ/U	ND(0.10) /U	ND(0.10) /U	ND(0.10) /U	ND(0.50) /UD	ND(0.10) /U	0.01 J/J	ND(0.10) /U
Benzo(a)anthracene	µg/l	ND(0.01) U/J	0.011 /J	ND(0.012) UJ/J	0.0099 /J	ND(0.011) U*/J	0.01 /J	ND(0.05) U/JD	0.0099 /J	ND(0.0098) UJ/J	0.0096 /J
Benzo(a)pyrene	µg/l	ND(0.10) /U	ND(0.10) /U	**0.013 J/J**	ND(0.10) /U	ND(0.10) /U	ND(0.10) /U	ND(0.50) /UD	ND(0.10) /U	**0.013 J/J**	ND(0.10) /U
Benzo(ghi)perylene	µg/l	ND(0.014) U/J	ND(0.10) /U	ND(0.10) UJ/U	0.037 /J	ND(0.013) U*/J	0.037 /J	ND(0.50) /UD	ND(0.10) /U	ND(0.10) UJ/U	0.035 /J
bis(2-Chloroethyl) ether	µg/l	**0.02 /J**	ND(0.10) /U	ND(0.10) UJ/U	ND(0.10) /U	ND(0.10) /U	ND(0.10) /U	ND(0.50) /UD	ND(0.10) /U	ND(0.10) UJ/U	**0.018 /J**
Naphthalene	µg/l	0.013 /J	ND(0.10) /U	0.013 J/J	0.014 /J	ND(0.015) U*/J	ND(0.10) /U	ND(0.50) /UD	ND(0.10) /U	0.016 J/J	ND(0.10) /U
N-Nitrosodiethylamine	µg/l	ND(0.10) /U	ND(0.10) /U	ND(0.10) UJ/U	ND(0.10) /U	ND(0.10) UJ*/U	**0.071 /J**	ND(0.50) /UD	ND(0.10) /U	ND(0.10) UJ/U	ND(0.10) /U
N-Nitrosodimethylamine	µg/l	ND(0.02) /U	ND(0.02) /U	ND(0.02) /U	ND(0.022) /UD	ND(0.02) /U	**0.18**	ND(0.02) /U	ND(0.02) /U	ND(0.02) /U	ND(0.02) /U
N-Nitrosodinpropylamine	µg/l	ND(0.10) /U	**0.064 /J**	ND(0.11) UJ/B	**0.037 /JB**	ND(0.10) /U	ND(0.10) /U	**0.49 /JD**	**0.05 /J**	ND(0.14) UJ/B	**0.039 /JB**
n-Nitrosopyrrolidine	µg/l	**0.36**	**0.14**	**0.55 J**	**0.17**	ND(0.10) /U	ND(0.10) /U	**1.5 /D**	**0.21**	**0.035 J/J**	ND(0.10) /U
OCDD	pg/l	ND(22.9) UJ	ND(4.91) /U	**29.1 J/J**	ND(7.83) /U	ND(37.6) U*/J	ND(10.3) /U	**72.4 J**	ND(4.54) /U	**25.1 J/J**	ND(6.41) /U
pH	ph	7.39	8.79	8.86	8.56	8.88	7.96	7.99	9.02	8.43	8.12
Total Dissolved Solids (TDS)	mg/l	21,000. /D	12,000. /D	43,000. /D	11,000. /D	20,000. /D	7,100. /D	39,000. /D	14,000. /D	24,000. /D	7,600. /D
Bromide	mg/l	280. /D	NT	550. /D	110. /D	160. /D	24. /D	37. /D	140. /D	260. /D	59. /D
Chloride	mg/l	6,300. /D	3,900. /D	21,000. /D	4,400. /D	6,600. /D	1,100. /D	12,000. /D	4,800. /D	9,000. /D	2,500. /D
Fluoride	mg/l	2.4 /JD	2.1 /D	2.7 /JD	ND(1.0) /UD	ND(2.5) /UD	ND(0.50) /UD	5.1 /D	2.3 /D	ND(5.0) /UD	1.2 /D
Nitrate (as NO3)	mg/l	ND(22.) /UD	ND(8.8) /UD	ND(44.) /UD	ND(8.8) /UD	4.0 /JD	17. /D	ND(22.) /UD	ND(8.8) /UD	ND(44.) /UD	ND(4.4) /UD
Nitrate as N	mg/l	ND(5.0) /UD	ND(2.0) /UD	ND(10.) /UD	ND(2.0) /UD	0.90 /JD	3.8 /D	ND(5.0) /UD	ND(2.0) /UD	ND(10.) /UD	ND(1.0) /UD
Sulfate	mg/l	6,600. /D	4,300. /D	12,000. /D	3,100. /D	6,600. /D	1,400. /D	13,000. /D	5,500. /D	7,500. /D	2,500. /D
Bicarbonate Alkalinity as CaCO3	mg/l	150. /D	37.	ND(10.) /UD	110. /D	34. /D	150. /D	260. /D	15.	91. /D	90. /D
Carbonate Alkalinity as CaCO3	mg/l	ND(5.0) /UD	78.	240. /D	93. /D	130. /D	ND(5.0) /UD	ND(10.) /UD	110.	110. /D	21. /D
1,2 Dibromoethane (EDB)	µg/l	**0.012**	ND(0.01) /U	ND(0.01) /U	**0.0068 /J**	ND(0.01) /U	ND(0.01) /U	ND(0.01) /U	0.0028 /JP	ND(0.01) /U	0.0054 /J
Diesel Range Organics (C12 - C24)	µg/l	390.	160. /J	430. J	240.	ND(240.) U*	170. /J	380.	290.	300. J	NT
TPH-Motor Oil	µg/l	210. /J	91. /J	91. J/J	110. /J	630.	230. /J	180. /J	180. /J	140. J/J	NT

Footnotes:
µg/l - micrograms per liter
mg/l - miligrams per liter
pg/l - picograms per liter
ND - not detected
NT - not tested
N - The anlysis indicates the presence of an anlyte for which there is presumptive evidence to make a tentative identification
Bold values indicate exceedances of one or more screening levels.
Qualifiers are listed as validation qualifier / lab qualifier where applicable (e.g.B/R)

Laboratory Assigned Qualifiers
B - Compound is also detected in the laboratory method blank.
U - Compound was analyzed for but not detected.
D - Compound is identified in an analysis at a secondary dilution factor.
J - Result is detected below the reporting limit or is an estimated concentration.

MACTEC Validation Assigned Qualifiers
J - Data are qualified as estimated. It is not possible to assess the direction of the potential bias. False positives or false negatives are unlikely to have been reported.
J- -Data are qualified as estimated, with a low bias likely to occur. False positives or false negatives are unlikely to have been reported.
J+ - Data are qualified as estimated, with a high bias likely to occur. False positives or false negatives are unlikely to have been reported.
U - Data are qualified as nondetected, because the analyte was observed in an associated laboratory or field blank.
J* - Analytical results for this compound are qualified as estimated due to miscellaneous lab errors.
Where validation qualifiers are absent, data was used for screening purposes only

Table 6-1
Estimated Physical and Chemical Properties of Detected Constituents

	Representative Constituent	CAS No.	Molecular Weight (gm/mol)	Solubility (mg/L @25C)	Henry's Constant (atm-m^3/mol @25C)	Vapor Pressure (mm Hg @25C)	K_{oc} (ml/gm)	K_{ow} (ml/gm)	Comments
VOCs									
	1,1-Dichloroethane	75-34-3	99	5040	5.62E-03	2.34E+02	31.6	6.20E+01	
	1,1-Dichloroethene	75-35-4	97	2250	2.61E-02	5.91E+02	58.9	1.35E+02	
	1,2-Dichloroethene	540-59-0	97	3500	4.08E-03	3.32E+02	35.5	1.00E+02	assuming cis-
	1,2-Dibromoethane	106-93-4	188	3400	3.20E-04	1.10E+01	28.1	9.12E+01	
	Acetone	67-64-1	58	1000000	3.88E-05	2.70E+02	0.575	5.75E-01	
	Benzene	71-43-2	78.1	1750	5.55E-03	9.52E+01	58.9	1.35E+02	
	Carbon disulfide	75-15-0	76	1190	3.03E-02	2.97E+02	45.7	8.71E+01	
	Diisopropyl ether	108-20-3	102.18	8800	9.78E-03	1.49E+02	168	3.31E+01	solubility @ 20C
	Ethylbenzene	100-41-4	106.2	169	7.88E-03	7.00E+00	363	1.41E+03	
	Freon 113	76-13-1	187.38	1100	5.21E-01	2.84E+02	160	1.45E+03	
	Methyl ethyl keton (MEK)	78-93-3	72	268000	2.74E-05	7.75E+01	4.5	1.95E+00	
	Methyl isobutyl ketone (MIBK)	108-10-1	100.16	19000	1.40E-04	1.45E+01	134	2.04E+01	
	Methyl cyclopentane	96-37-7	84.16	42	3.61E-01			2.34E+03	solubility @ 25C
	Methylene chloride	75-09-2	84.93	13200	2.19E-03	4.11E+02	11.7	1.78E+01	
	Nonanal	124-19-6	142.24	96	7.34E-04			1.86E+03	Kow estimated, solubility @ 25C
	Propanal	123-38-6	58.08	306000	7.34E-05	3.17E+02	50	3.89E+00	solubility @ 25C
	Tetrahydrofuran	109-99-9	72.11	1000000	7.00E-05	1.62E+02	0.95	2.88E+00	
	Toluene	108-88-3	92	526	6.64E-03	2.84E+01	182	5.37E+02	
	1,1,1-Trichloroethane	75-55-6	133	1330	1.72E-02	1.24E+02	110	3.09E+02	
	1,1,2-Trichloroethane	79-00-5	133	4420	9.13E-04	2.60E+01	50.1	1.48E+02	
	Trichloroethylene	79-01-6	131	1100	1.03E-02	7.43E+01	166	4.07E+02	
	Acetonitrile	75-05-8	41	1000000	2.00E-05	8.88E+01	15.6	4.57E-01	
	Acrolein	107-02-8	56	210000	1.20E-04	2.20E+02	21.2	1.00E-01	
	Ethylene glycol	107-21-1	62.07	1000000	6.00E-08	9.20E-02	4	4.37E-02	miscible with water
	Isopropanol	67-63-0	60.1	1000000	8.10E-06	4.30E+01	25	1.12E+00	miscible with water
	Tert-butyl alcohol (TBA)	75-65-0	74.12	1000000	9.05E-06	4.17E+01	37	2.24E+00	miscible with water
SVOCs									
	Bis(2-chloroethyl)ether	111-44-4	143.01	10200	2.90E-05	1.55E+00	76	1.95E+01	solubility @ 20C
	Bis(2-ethylhexyl)phthalate	117-81-7	390.57	0.285	1.10E-05	9.75E-06	87420	3.98E+07	solubility @ 24C
	Diethylphthalate	84-66-2	222.24	1000	6.10E-07	1.65E-03	98	2.95E+02	solubility @ 25C
	N-nitrosodiethylamine,	55-18-5	102.14	93000	4.01E-06	8.60E-01	no data	3.02E+00	vapor pressure @ 20C
	N-Nitrosodipropylamine	621-64-7	130.22	9900	5.38E-06	2.00E-01	28	2.29E+01	
	N-Nitrosopyrrolidine	930-55-2	100.12	1000000	4.89E-08	6.00E-02	19	6.46E-01	miscible with water, vapor pressure @ 20C
PAHs									
	Benzo(a)anthracene	56-55-3	228.29	9.40E-03	8.00E-06	no data	2.00E+05	6.17E+05	
	Benzo(a)pyrene	50-32-8	252.32	1.60E-03	4.57E-07	5.49E-09	5.07E+06	9.33E+05	
	Benzo(b)fluoranthene	205-99-2	252.32	1.50E-03	1.38E-04	5.00E-07	759000	3.98E+06	vapor pressure @ 20C
	Benzo(ghi)perylene	191-24-2	276.34	2.60E-04	2.66E-07	1.00E-10	400000	4.27E+06	
	Dibenzo(ah)anthracene	53-70-3	278.33	5.99E-04	1.20E-07	2.78E-12	2.00E+06	3.16E+06	
	Naphthalene	91-20-3	128.17	31	4.40E-04	8.50E-02	23000	2.90E+04	
Herbicides									
	2,4-DB,	94-82-6	349.09	46	2.29E-09	3.50E-06	370	3.39E+03	
	Dalapon	75-99-0	142.97	502000	6.40E-08	1.90E-01	2.3	6.03E+00	
	Dichlorprop	120-36-5	235.07	350	1.22E-08	1.40E-05	118	2.69E+03	solubility @ 20C
	MCPA	94-74-6	200.6	630	4.80E-10	5.90E-06	50	1.78E+03	
	MCPP	93-65-2	214.6	620	1.82E-08	no data	8.4	1.35E+03	
Pesticides									
	4,4'-DDD	72-54-8	320.05	0.16	2.16E-05	1.02E-06	43651.58322	9.77E+05	
	4,4'-DDE	72-55-9	319.03	0.04	2.34E-05	1.57E-05	1000000	6.76E+05	
	4,4'-DDT	50-29-3	354.49	0.0032	3.80E-05	4.30E-07	239883.2919	2.29E+06	
	alpha-Chlordane	5103-71-9	409.78	0.056	8.36E-04	5.03E-05	2000000	1.00E+06	
	Endosulfan I	959-98-8	406.9	0.53	1.01E-04	1.00E-05	2042	3.55E+03	
	Endosulfan II	33213-65-9	406.92	0.28	1.91E-05	1.00E-05	2340	6.76E+03	
	Endosulfan sulfate	1031-07-8	422.95	0.48	4.70E-04	1.00E-05	2340	4.57E+03	solubility @20C

Table 6-1
Estimated Physical and Chemical Properties of Detected Constituents

	Representative Constituent	CAS No.	Molecular Weight (gm/mol)	Solubility (mg/L @25C)	Henry's Constant (atm-m^3/mol @25C)	Vapor Pressure (mm Hg @25C)	K_{oc} (ml/gm)	K_{ow} (ml/gm)	Comments
	Endrin	72-20-8	380.91	0.25	6.36E-06	7.00E-07	34000	1.58E+05	solubility @25C
	Heptachlor	76-44-8	373.32	0.18	2.94E-04	3.00E-04	3475	1.26E+06	solubility @25C
	Hexachlorobenzene	118-74-1	284.78	0.11	1.70E-03	1.90E-05	3890.45145	2.82E+05	
	Kepone	143-50-0	490.64	2.7	5.30E-08	2.25E-07	2600	2.57E+05	solubility @25C
	Methoxychlor	72-43-5	345.65	0.1	2.03E-07	1.43E-06	80000	1.20E+05	solubility @25C
Dioxins									
	Chlorindated Dioxins	--	390 - 425	$2.4x10^{-6}$ to $4.4x10^{-6}$	$1.3x10^{-6}$ to $5x10^{-6}$	$3.8x10^{-11}$ to $6x10^{-12}$	no data	$2.5x10^{10}$ to $2.4x10^{11}$	properties for hexa- and hepta-chlorodibenzo-p-dioxins
	Chlorindated Dibenzofurans	--	--	--	--	$1.8x10^{-10}$ to $3.8x10^{-12}$	no data	$1x10^{7}$ to $1x10^{8}$	properties for hexa- through octa-chlorodibenzofurans
PCBs									
	Aroclor 1260	11096-82-5	375.7	0.027	3.36E-04	4.05E-05	2.63E+06	6.31E+06	average; solubility @25C
Metals									
	Antimony	7440-36-0	121.75	NA	NA	NA	NA	NA	
	Arsenic	7440-38-2	74.9	NA	NA	NA	NA	NA	
	Barium	7440-39-3	137.33	NA	NA	NA	NA	NA	
	Beryllium	7440-41-7	9	NA	NA	NA	NA	NA	
	Cadmium	7440-43-9	112.4	NA	NA	NA	NA	NA	
	Chromium	7440-47-3	52	NA	NA	NA	NA	NA	
	Cobalt	7440-48-4	58.9	NA	NA	NA	NA	NA	
	Copper	7440-50-8	63.6	NA	NA	NA	NA	NA	
	Lead	7439-92-1	207.2	NA	NA	NA	NA	NA	NA - not applicable
	Manganese	7439-96-5	54.9	NA	NA	NA	NA	NA	
	Mercury	7439-97-6	200.6	NA	NA	NA	NA	NA	
	Molybdenum	7439-98-7	95.9	NA	NA	NA	NA	NA	
	Nickel	7440-02-0	58.7	NA	NA	NA	NA	NA	
	Selenium	7782-49-2	78.9	NA	NA	NA	NA	NA	
	Silver	7440-22-4	107.8	NA	NA	NA	NA	NA	
	Thallium	7440-28-0	204.4	NA	NA	NA	NA	NA	
	Tin	7440-31-5	118.69	NA	NA	NA	NA	NA	
	Vanadium	7440-62-2	50.9	NA	NA	NA	NA	NA	
	Zinc	7440-66-6	65.38	NA	NA	NA	NA	NA	
Cyanide									
	Hydrogen cyanide	74-90-8	27.03	1000000	5.10E-02	6.30E+02	NA	11.75	miscible with water, vapor pressure @ 20C
Sulfide									
	Hydrogen sulfide	7783-06-4	34.08	4,100	NA	1.56E+04	NA	NA	solubility @20C

Notes:

atm - atmosphere
C - centigrade
CAS No. - Chemical Abstracts Service Number
gm - gram
K_{oc} - organic carbon partition coefficient
K_{ow} - octanol-water partition coefficient
L - liter
m^3 - cubic meter
mg - milligram
ml - milliliter
mm Hg - millimeters of mercury (pressure measurement unit)
mol - gram-mole or gmole
NA - not applicable
S - solubility
VP- vapor pressure

Table 6-2
Summary of Detected Chemicals by
Chemical Analyte Classes and Environmental Media Where Detected

Chemical Analyte Class	Representative Chemicals[1]	Environmental Media				
		Soil Vapor	Surface and Subsurface Soil	Sediment	Surface Water	Ground-water
VOCs, including PPO compounds	1,1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichloroethene, 1,2-Dibromoethane (EDB), Acetone, Benzene, Carbon disulfide, Diisopropyl ether, Ethylbenzene, Freon 113, Methyl ethyl ketone (MEK), Methyl isobutyl ketone (MIBK), Methyl cyclopentane, Methylene chloride, Nonanal, Propanal, Tetrachloroethylene, Tetrahydrofuran, Toluene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, Trichloroethylene, Acetonitrile, Acrolein, Ethylene glycol, Isopropanol, Tert-butyl alcohol (TBA)	X	X	X	X	X
SVOCs	Bis(2-chloroethyl)ether, Bis(2-ethylhexyl)phthalate, Diethylphthalate N-nitrosodiethylamine, N-Nitrosodipropylamine, N-Nitrosopyrrolidine		X		X	X
PAHs	Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Dibenzo(a,h)anthracene, Naphthalene		X	X	X	X
Herbicides	2,4-dichlorophenoxybutyric acid (2,4-DB), Dalapon, Dichlorprop, MCPA, MCPP		X	X		X
Pesticides	4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha-Chlordane, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Heptachlor, Hexachlorobenzene, Kepone, Methoxychlor		X	X		X
Dioxins/furans	Polychlorinated dioxins (PCDD), polychlorinated dibenzofurans (PCDF)		X	X	X	X
PCBs	Aroclor 1260, PCB Congeners		X	X		X
Metals	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Vanadium, and Zinc		X	X	X	X
Cyanide	Amenable and total cyanide		X			X
Sulfide	Sulfide			X		X

[1] List of representative chemicals presented above does not reflect all compounds detected. Refer to Appendix G of RI Report for a comprehensive listing (CSC 2011).

Table 6-3
Relative Mobility of Chemical Analytical Classes and Representative Chemicals

Chemical Analyte Class	Representative Chemicals[1]	Volatility	Solubility	Sorption Potential	Bioaccumulation Potential
VOCs, including PPO compounds	1,1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichloroethene, 1,2-Dibromoethane (EDB), Acetone, Benzene, Carbon disulfide, Diisopropyl ether, Ethylbenzene, Freon 113, Methyl ethyl ketone (MEK), Methyl isobutyl ketone (MIBK), Methyl cyclopentane, Methylene chloride, Nonanal, Propanal, Tetrachloroethylene, Tetrahydrofuran, Toluene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, Trichloroethylene, Acetonitrile, Acrolein, Ethylene glycol, Isopropanol, Tert-butyl alcohol (TBA)	High	Medium to High	Low to Medium	Low
SVOCs	Bis(2-chloroethyl)ether, Bis(2-ethylhexyl)phthalate, Diethylphthalate N-nitrosodiethylamine, N-Nitrosodipropylamine, N-Nitrosopyrrolidine	Low to Medium	Low	Medium to High	Low to Medium
PAHs	Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Dibenzo(a,h)anthracene, Naphthalene	Low to Medium	Low	High	Low to Medium
Herbicides	2,4-dichlorophenoxybutyric acid (2,4-DB), Dalapon, Dichlorprop, MCPA, MCPP	Low	Low	Medium to High	Medium to High
Pesticides	4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha-Chlordane, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Heptachlor, Hexachlorobenzene, Kepone, Methoxychlor	Low	Low	High	High
Dioxins/furans	Polychlorinated dioxins (PCDD), polychlorinated dibenzofurans (PCDF)	Low	Low	High	High
PCBs	Aroclor 1260, PCB Congeners	Low	Low	High	High

Table 6-3
Relative Mobility of Chemical Analytical Classes and Representative Chemicals

Chemical Analyte Class	Representative Chemicals[1]	Volatility	Solubility	Sorption Potential	Bioaccumulation Potential
Metals	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Vanadium, and Zinc	Low	Low to Medium	Medium to High	Low to Medium
Cyanide	Amenable and total cyanide (Hydrogen Cyanide)	High	High	Low	Low
Sulfide	Sulfide (Hydrogen Sulfide)	High	Low	Low	Low

[1] List of representative chemicals presented above does not reflect all compounds detected. Refer to Appendix G of RI Report for a comprehensive listing (CSC 2011).

Table 6-4
Relative Degradation Potential of Detected Chemicals in Various Chemical Analyte Classes

Chemical Analyte Class	Chemical[1]	Atmospheric Degradation Potential	Aquatic Degradation Potential	Terrestrial Degradation Potential
VOCs, including PPO compounds	Aromatic VOCs (e.g., benzene, toluene, ethylbenzene)	High	High	High
	Halogenated ethenes and ethanes (e.g., 1,1,1-trichloroethane, trichloroethylene)	Low/Moderate	Low/Moderate	Low/Moderate
	Alcohols, Ketones, and ethers (e.g., TBA, acetone, MEK, MIBK)	High	High	Moderate/High
SVOCs	Bis(2-chloroethyl)ether	Low	Low	Low
	Bis(2-ethylhexyl)phthalate	Moderate	Moderate	Low/Moderate
	N-nitrosodiethylamine	Moderate	Moderate	Moderate
	N-Nitrosodipropylamine	Moderate	Moderate	Low/Moderate
	N-Nitrosopyrrolidine	Moderate	Low/Moderate	Low/Moderate
PAHs	Benzo(a)anthracene	High	Low/Moderate	Low/Moderate
	Benzo(a)pyrene	High	Low/Moderate	Low/Moderate
	Benzo(b)fluoranthene	High	Low/Moderate	Low/Moderate
	Benzo(g,h,i)perylene	High	Low/Moderate	Low/Moderate
	Dibenzo(a,h)anthracene	High	Low/Moderate	Low/Moderate
	Naphthalene	High	High	High
Herbicides	2,4-dichlorophenoxybutyric acid (2,4-DB)	Moderate	Moderate	Moderate
	Dalapon	Moderate	Low/Moderate	Low/Moderate
	Dichlorprop	Moderate	Low	Low/Moderate
	MCPA	Moderate	Low/Moderate	Moderate
	MCPP	Moderate	Moderate	Moderate
Pesticides	4,4'-DDD	Low	Low	Low
	4,4'-DDE	Low	Low	Low
	4,4'-DDT	Low	Low	Low
	alpha-Chlordane	Low/Moderate	Low	Low
	Endosulfan I	Low/Moderate	Moderate	Low/Moderate
	Endosulfan II	Low/Moderate	Moderate	Low/Moderate
	Endosulfan sulfate	Low/Moderate	Moderate	Low/Moderate
	Endrin	Low/Moderate	Low	Low
	Heptachlor	Moderate	Moderate	Low
	Hexachlorobenzene	Low	Low	Low
	Kepone	Low	Low	Low
	Methoxychlor	Moderate	Low/Moderate	Low/Moderate
Dioxins/furans	Polychlorinated dioxins (PCDD), polychlorinated dibenzofurans (CDF)	Low	Low	Low
PCBs	Aroclor 1260, and PCB Congeners	Low/Moderate	Low	Low
Metals	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Tin, Vanadium, Zinc	Low	Low	Low

Table 6-4
Relative Degradation Potential of Detected Chemicals in Various Chemical Analyte Classes

Chemical Analyte Class	Chemical[1]	Atmospheric Degradation Potential	Aquatic Degradation Potential	Terrestrial Degradation Potential
Cyanide	Amenable and total cyanide (Hydrogen Cyanide)	Low/Moderate	Low/Moderate	Low/Moderate
Sulfide	Sulfide (Hydrogen Sulfide)	High	Moderate	Moderate

1 List of representative chemicals presented above does not reflect all compounds detected. Refer to Appendix G of RI Report for a comprehensive listing (CSC 2014).

TABLE 7-1

CHEMICALS OF CONCERN[1] IN SURFACE SOIL - TERRESTRIAL BIRDS, SOIL INVERTEBRATES, AND PLANTS

Exposure Area	Tier 1 ERA	Tier 2 ERA[2]	Human Health[3]
RCRA Canyon Area	*Risk-driving COPECs identified for further evaluation in the Tier 2 ERA*: Cadmium, Chromium, Lead, and Zinc	Chromium, Copper, and Zinc	None
WCSA	*Risk-driving COPECs identified for further evaluation in the Tier 2 ERA*: Cadmium, Chromium, Copper, and Zinc	Chromium, Copper, and Zinc	
Administration Building Area	None	None	None
Roadway Area	*Risk-driving COPEC identified for further evaluation in the Tier 2 ERA*: Chromium	Chromium and Copper	None
Remaining Onsite Area	None	None	None
Former Ponds and Pads Areas	None	None	None
Liquid Treatment Area[4]	Cadmium, Chromium, Vanadium, MCPP, DDT, total DDT, and Hexachlorobenzene	--	MCPP
Burial Trench Area[4]	Chromium, Vanadium, and TCE	--	None
Maintenance Shed Area[4]	Cadmium, Chromium, Lead, Vanadium, and DDE, and Total DDT	--	None
Central Drainage Area[4]	Chromium, Vanadium, Dioxin TEQ, Total TEQ, Bis (2-ethylhexyl)phthalate, and Endrin[3]	--	None
A-Series Pond[4]	Cadmium and Selenium	--	None
RCF Pond[4]	Chromium	--	None
Pond A-5[4]	Cadmium, Chromium, and Selenium	--	None
Pond 13[4]	Cadmium and Selenium	--	None
Pond 18[4]	Cadmium and Chromium, and Selenium	--	None

-- Exposure area not evaluated in Tier 2 Ecological Risk Assessment (ERA).

COPECs = chemicals of potential ecological concern.

[1] = Chemicals of concern (COCs) are those chemicals of potential concern that have been identified in the quantitative risk assessment as exceeding a risk threshold and therefore warranting further evaluation in the Feasbility Study. For areas with planned presumptive remedies, COCs are based on the results of the Tier 1 ERA. For areas with no planned presumptive remedies, COCs are based on the results of the Tier 2 ERA and the human health risk assessment (HHRA).

[2] = COCs based on terrestrial birds only

[3] = COCs based on commercial/industrial worker exposures and target risk of > 1×10^{-5} and hazard quotient of > 1.

[4] = Exposure area has a presumptive remedy in place and was not evaluated in the Tier 2 ERA.

TABLE 7-2

CHEMICALS OF CONCERN[1] IN SHALLOW SOIL - TERRESTRIAL MAMMALS, SOIL INVERTEBRATES, AND PLANTS

Exposure Area	Tier 1 ERA	Tier 2 ERA[2]	Human Health[3]
RCRA Canyon Area	*Risk-driving COPECs identified for further evaluation in the Tier 2 ERA:* Cadmium, Chromium, Copper, and Zinc	None	None
WCSA	*Risk-driving COPECs identified for further evaluation in the Tier 2 ERA:* Cadmium, Chromium, Copper, and Zinc	None	
Administration Building Area	None	None	None
Roadway Area	*Risk-driving COPECs identified for further evaluation in the Tier 2 ERA:* Chromium and Zinc	None	None
Remaining Onsite Area	None	None	None
Former Ponds and Pads Areas	*Risk-driving COPEC identified for further evaluation in the Tier 2 ERA:* Zinc	None	PCE
Liquid Treatment Area[4]	Cadmium, Molybdenum, Selenium, Zinc, DDT, Total DDT, MCPP, Hexachlorobenzene, and Mirex	--	MCPP
Burial Trench Area[4]	Molybdenum, Selenium, and Zinc	--	TCE
Maintenance Shed Area[4]	Cadmium, Chromium, Lead, Lead, Zinc, Dioxin TEQ, and Toral TEQ	--	None
Central Drainage Area[4]	Molybdenum, Zinc, Dioxin TEQ, and Total TEQ	--	PCE
A-Series Pond[4]	Cadmium, Molybdeum, Selenium, and Zinc	--	None
RCF Pond[4]	Molybdeum, Selenium, and Zinc	--	None
Pond A-5[4]	Barium, Cadmium, Molybdenum, Selenium, and Zinc	--	None
Pond 13[4]	Cadmium, Selenium, and Zinc	--	None
Pond 18[4]	Cadmium, Molybdeum, Selenium, and Zinc	--	None

-- Exposure area not evaluated in Tier 2 Ecological Risk Assessment (ERA).
COPECs = chemicals of potential ecological concern.

[1] = Chemicals of concern (COCs) are those chemicals of potential concern that have been identified in the quantitative risk assessment as exceeding a risk threshold and therefore warranting further evaluation in the Feasbility Study. For areas with planned presumptive remedies, COCs are based on the results of the Tier 1 ERA. For areas with no planned presumptive remedies, COCs are based on the results of the Tier 2 ERA and the human health risk assessment (HHRA).

[2] = COCs based on terrestrial birds only

[3] = COCs based on commercial/industrial worker exposures and target risk of > 1×10^{-5} and hazard quotient of > 1. PCE and TCE were also identfied as a COC for off-site exposures due to volatilization into outdoor air.

[4] = Exposure area has a presumptive remedy in place and was not evaluated in the Tier 2 ERA.

TABLE 7-3

CHEMICALS OF CONCERN[1] IN SEDIMENT BASED ON AQUATIC WILDLIFE AND SEDIMENT INVERTEBRATES

Exposure Area	Tier 1 ERA	Tier 2 ERA	Human Health
A-Series Pond	Arsenic, Chromium, Manganese, Mercury, Molybdenum, Selenium, Vanadium, and Zinc	--	None
RCF Pond	Chromium, Avian PCB TEQ, Total TEQ, and MCPP	--	None
Pond A-5	Cadmium, Chromium, Selenium, and MCPP	--	None
Pond 13	None	--	None
Pond 18	Chromium, Selenium, and MCPP	--	None

-- Exposure area not evaluated in Tier 2 Ecological Risk Assessment (ERA).

[1] =No chemicals of concern (COCs) were identified for sediment in the Tier 2 ERA as all of the ponds will have presumptive remedies in place as part of the USEPA-approved closure plan for the site and will be backfilled/graded to prevent accumulation of water, they will be unavailable as a pathway for aquatic receptors, essentially eliminating the potential for adverse effects to aquatic receptors.

TABLE 8-1
SUMMARY OF AREAS FOR FS EVALUATION
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

NO.	STUDY AREA	MEDIA	CHEMICALS OF CONCERN	RISK CONSIDERATION	NEED FOR FS EVALUATION?	AREAS FOR FS EVALUATION	SUMMARY COMMENTS
SOIL							
1	Capped Landfills Area - P/S, Heavy metals, Acids, Caustic/cyanide Landfills	Soil	VOCs and Other Organics in deep soil DNAPL and LNAPL in P/S landfill (free phase NAPL present under the P/S Landfill)	GW protection DNAPL LNAPL	No (P/S Landfill will be evaluated under Groundwater Study Area)	**AREA 1**	The FS does not discuss the Capped Landfills study area in the FS because the previously constructed RCRA Caps (and continued Monitoring, Maintenance of those caps), ICs, and GW monitoring are assumed as the final remedy for this area of the site. The above remedy mitigates potential groundwater contaminant migration and eliminates any ecological or human health risks. The P/S Landfill is evaluated under the groundwater evaluation, under Area 5 North.
2	PCB Landfill	Soil	N/A	GW protection HH risk Ecological-risk	Yes		Capping is considered a presumed remedial action for the PCB landfill after any impacted (metals, VOCs, other) soils excavated from other study areas are placed in this landfill. Groundwater protection is a risk consideration for FS alternatives for each of these study areas. No Tier 2 evaluation was conducted at BTA and CDA because of a presumed cap remedy. Human health risk identified in the risk assessment refers to a hypothetical offsite resident from excavation and transportation of impacted soils. As discussed in Section 7, barium (which was listed as a risk-driving chemical in the RI) is not considered a chemical of concern here.
3	Burial Trench Area (BTA)	Soil	Metals (Cr, Mo, Se, Zn, Va) in central and southern area VOCs (TCE) and Other Organics in soil, residual NAPL in deep soil	Ecological-risk HH risk GW protection	Yes		
4	Central Drainage Area (CDA)	Soil	Metals (Cu) in western portion VOCs (MC, PCE, TCE, 1,1-DCA, 1,2-DCA) and Other organics in western portion of area, south of P/S landfill DNAPL and LNAPL (free phase NAPL present)	Ecological-risk HH risk GW protection DNAPL LNAPL	Yes		
5	RCRA Canyon Area	Soil	Metals (Cr, Cu, Zn) in 0-5' bgs soil in most areas of northern and western slope of canyon. Some locations within impacted areas have deeper (>5' bgs) metals contamination in soil.	Ecological-risk GW Protection	Yes	**AREA 2**	The ecological receptors of concern identified during the ERA are the western meadowlark and the ornate shrew. As discussed in Section 7, barium (which was listed as a risk-driving chemical in the RI) is not considered a chemical of concern here.
6	West Canyon Spray Area (WCSA)	Soil	Metals (Cr, Cu, Zn) in 0-5' bgs soil in central and southern area, eastern slope of canyon		Yes		
7	Liquids Treatment Area	Soil	MCPP, DDT in surface soil Metals (Cu, Zn) in surface and shallow soil	HH risk Ecological-risk GW protection	Yes	**AREA 3**	No separate FS evaluation for this study area was necessary because the HI of 2 was primarily driven by one sample with elevated MCPP and the locations with elevated risks are evaluated as part of the hotspots locations in Area 3. Planned asphalt cap would address MCPP, DDT and low metals.
8	Maintenance Shed Area	Soil	Metals (Cd, Cr, Pb, Va), DDT in surface soil TPH in shallow soils (diesel, motor oil)	Ecological-risk HH risk GW protection	Yes		No separate FS evaluation was completed for this study area because removal of existing fuel tanks and associated contaminated soil is a presumed remedial action and locations with elevated metals, DDT are evaluated as part of the hotspots in Area 3. No Tier 2 ecological-risk evaluation conducted because of presumptive removal of TPH-impacted soils.
9	Administration Building Area	Soil	None	None	No		This RI Study Area was screened out of FS evaluation because there is no risk.
10	Roadways	Soil	Metals (Cr, Zn, Cu) in shallow soil	Ecological-risk GW protection	Yes		Soil locations in Area 3 with elevated concentrations of contaminants will be evaluated for capping or excavation using a risk-based approach.
11	Remaining Onsite Areas (Near SW ponds and SE portion of site)	Soil	Metals (Mo, Se) PAHs, PPCs, SVOCs in deep soil in the southern portion of site near RCF pond (RISBON-59)	Ecological-risk HH risk HH offsite GW protection	Yes		

TABLE 8-1
SUMMARY OF AREAS FOR FS EVALUATION
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

NO.	STUDY AREA	MEDIA	CHEMICALS OF CONCERN	RISK CONSIDERATION	NEED FOR FS EVALUATION?	AREAS FOR FS EVALUATION	SUMMARY COMMENTS
12	Former Pads and Ponds Subarea (areas south of PSCT not used for waste management)	Soil	Metals (Cu, Zn), PCBs, DDT VOC (PCE) and Other organics in soil in Pond A, B in north central area		Yes		
13	Offsite Areas -A, B and C drainages -North Drainage area	Soil Soil vapor	None Except soil vapor (low level VOCs at North ridge)	None	No	--	No formal evaluation for this study area was included in the FS because RI shows no impacts. Low level soil vapor concentrations present in the north ridge will be addressed by ICs (deed restrictions).
14	Stormwater Ponds (RCF pond, A series ponds and Pond 13)	Surface water Sediment	Metals (As), PCBs and pesticides in surface water Metals (Cd, Se, Cr, Zn), PCBs and pesticide in sediment	HH risk Ecological-risk GW protection	Yes	**AREA 4**	No Tier 2 ecological risk evaluation conducted on these features based on the assumption the ponds would be closed. As discussed in Section 7, barium (which was listed as a risk-driving chemical in the RI) is not considered a chemical of concern here.
15	Treated Liquid Impoundments (Pond A-5, 18)	Surface water Sediment	Metals (As) in surface water Metals (Cd, Cr, Cu, Se, Mo, Zn) in sediment	HH risk Ecological-risk GW protection	Yes		
GROUNDWATER							
16	Northern Groundwater Area (North of PSCT)	Groundwater DNAPL LNAPL	High concentrations of VOCs and other Organics, metals in groundwater in Upper HSU and lower levels in Lower HSU Free DNAPL and LNAPL in the Upper HSU within the P/S landfill and to a lower extent in the Lower HSU in the Central Drainage Area	GW protection DNAPL migration	Yes	**AREA 5 NORTH**	A request to grant a TI waiver for groundwater in this area is included with this report. DNAPL and LNAPL located in the P/S landfill are considered a part of Area 5 North.
17	Southern Groundwater Area (South of PSCT)	Groundwater	Low to moderate concentrations of VOCs and metals in groundwater in Upper HSU. NAPL does not occur. Groundwater is also elevated in TDS.	GW protection	Yes	**AREA 5 SOUTH**	Unlike Area 5 North groundwater, no TI waiver is requested for Area 5 South groundwater.
18	RCRA Canyon Groundwater Area	Groundwater	Low to moderate concentrations of metals in groundwater. NAPLs do not occur. Groundwater is also elevated in TDS.	GW protection	Yes	**AREA 5 WEST**	Unlike Area 5 North, no TI waiver is requested for Area 5 West groundwater.
19	Offsite Groundwater Area	Groundwater	None	GW protection	No	--	The FS does not consider any remedial actions because there is no offsite migration of groundwater contaminants based on the existing controls and groundwater monitoring activities are presumed to continue in the future.
STORM WATER							
20	Capped Area Storm water	Stormwater Sediments	Metals, Organics Stormwater runoff from FS Area 1 and Capped RCRA Canyon area is expected to be clean because these areas are capped and is discharged offsite to the B-Drainage.	Offsite migration - storm water, sediments	Yes	**SITE-WIDE**	Not listed formally as a study area during the RI process but is included in the FS as a site-wide long term engineering control of any potential offsite migration of impacted surface water or sediments. Stormwater runoff is collected and discharged offsite via the B-Drainage under the General NPDES permit
21	RCRA Canyon Storm water	Stormwater Sediments	Metals (As, Ni, Se), Organics Stormwater and groundwater seepage runoff from the RCRA Canyon is currently discharged to the A-Series Pond. Groundwater seepage occurs in the southern part of the Canyon and continues for several weeks after a rain event. This runoff is elevated in metals and TDS.	Offsite migration - storm water, sediments	Yes	**SITE-WIDE**	Not listed formally as a study area during the RI process but is included in the FS as a site-wide long term stormwater control of any potential offsite migration of impacted surface water or sediments. If the RCRA Canyon/WCSA is addressed by capping and/or clean soil cover then the stormwater would be eligible for discharge offsite under the site's General Permit.

TABLE 8-1
SUMMARY OF AREAS FOR FS EVALUATION
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

NO.	STUDY AREA	MEDIA	CHEMICALS OF CONCERN	RISK CONSIDERATION	NEED FOR FS EVALUATION?	AREAS FOR FS EVALUATION	SUMMARY COMMENTS
			Concentrations of select metals (As, Ni, Se) in RCRA Canyon runoff are higher than maximum concentrations in offsite drainage water.				
22	Uncapped Area Storm water (outside of RCRA Canyon)	Stormwater Sediments	Metals, Organics and TDS Stormwater runoff is discharged to RCF Pond and Pond 13. Concentrations of metals, organics and TDS are not measured.	Offsite migration - storm water, sediments	Yes	**SITE-WIDE**	Not listed formally as a study area during the RI process but is included in the FS as a site-wide long term stormwater control of any potential offsite migration of impacted surface water or sediments.

NOTES

1. This table presents chemicals of concern (COCs), impacted media and risk type by study area. COCs are chemical of potential concern that were identified in the quantitative risk assessment as exceeding a risk threshold and warranting further evaluation in the Feasibility Study (FS). A human health and ecological risk assessment was completed to identify COCs. Two tiers of ecological risk assessments were conducted. The Tier 1 assessment identified two sets of chemicals (1) those requiring further evaluation in the Tier 2 assessment, for areas with no planned presumptive remedies, and (2) those considered COCs for areas with planned presumptive remedies based on the Tier 1 assessment, and not further evaluated in the Tier 2 assessment. The Tier 2 assessment identified COCs for areas with no planned presumptive remedies. The study areas #1 through #15 are focused on soil contamination while study areas #16 through #19 are related to groundwater and #20 through #22 related to stormwater.
   This table combines study areas based on contaminant type, media or proximity to define five new FS Areas for FS evaluation purposes.
2. Comments are provided in the rightmost column to provide additional perspective or explanation.

TABLE 8-2
TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL, SOIL VAPOR, AND SEDIMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
Objectives:	No Action:	No Action: Presumptive Remedy:	No Action No Further Action
1. Prevent on-site human health exposures to risk-driving chemicals in soil, soil vapor, and sediment such that total carcinogenic risks are less than 10^{-4} to 10^{-6} and non-cancer hazard indices are less than 1.	Institutional Controls:	Access Restrictions: Deed Restrictions: Monitoring:	Fencing / Notices Deed Restrictions Landfill Cap Monitoring Groundwater Quality Monitoring Soil Vapor Monitoring
2. Prevent ecological receptor exposures to risk driving chemicals in soil, soil vapor, and sediment such that exposures are below acceptable target levels.	Containment:	Capping:	RCRA Prescriptive Cap RCRA-equivalent / Monolithic Cap RCRA-equivalent Hybrid Cap Evapotranspiration Cap Concrete/Asphalt Cap
3. Mitigate the potential for downward migration of contaminants in soil and sediment that could adversely affect groundwater quality.	In-Situ Treatment:	Physical Treatment: Chemical Treatment: Biological Treatment:	Soil Vapor Extraction Steam Enhanced Extraction In-situ Thermal Desorption Electric Resistance Heating Stabilization / Fixation Biostimulation Bioventing
	Removal:	Excavation:	Waste Excavation Soil Excavation Tank Removal Sediment Removal

TABLE 8-2
TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL, SOIL VAPOR, AND SEDIMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
	Ex-Situ Treatment:	Biological Treatment:	Biopiles / Bioventing Bioremediation/Landfarming
		Thermal Treatment:	Thermal Desorption Incineration
		Physical Treatment:	Soil Vapor Extraction in soil piles Aeration Sludge Dewatering Soil Washing
		Chemical Treatment:	Pozzolanic Stabilization Polysilicate Fixation Asphaltic Recycling Chemical Oxidation Solvent Washing
	Disposal / Reuse:	Disposal:	Permitted Landfill Onsite Landfill disposal
		Reuse:	On-site Backfill

TABLE 8-3
TECHNOLOGIES AND PROCESS TREATMENT OPTIONS FOR SURFACE WATER, GROUNDWATER AND NAPL
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
Objectives:	No Action:	No Action:	No Action
1. Prevent onsite human health exposures to risk-driving chemicals in surface water and groundwater such that that total carcinogenic risks are less than 10^{-4} to 10^{-6} and non-cancer hazard indices are less than 1.	Institutional Controls:	Deed Restrictions: Access Restrictions: Monitoring:	Deed Restrictions Fencing / Notices Groundwater Quality Monitoring
2. Prevent ecological exposures to risk-driving chemicals in surface water such that exposures are below acceptable levels.	Containment:	Barrier Wall: Natural Attenuation:	Slurry Wall Monitored Natural Attenuation
3. Restore groundwater quality to applicable standards in areas of the site where technically practicable. 4. Contain and/or control contamination sources, where groundwater restoration is not technically practicable. 5. Remove NAPL in source areas early, to the extent practicable, and in general, where significant reduction in current or future risk will result.	In-Situ Treatment:	Chemical Treatment: Biological Treatment: Physical Treatment:	Chemical Oxidation Chemical Reduction Precipitation Injection approach or Reactive Wall In-situ soil mixing (large auger) In-situ flushing (surfactant/cosolvent) Biosparging Bioremediation, Anaerobic Bioremediation, Aerobic Injection approach or Biobarrier Air Sparging Hot Air Injection / Vacuum Extraction Dual Phase Vacuum Extraction In-Well Aeration Dynamic Underground Stripping In-situ Thermal Desorption Electric Resistance Heating

TABLE 8-3
TECHNOLOGIES AND PROCESS TREATMENT OPTIONS FOR SURFACE WATER, GROUNDWATER AND NAPL
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGY TYPES	PROCESS OPTIONS
6. Contain and/or control NAPL in source areas where removal is not technically practicable. 7. Mitigate potential off-site groundwater contamination via perimeter control.	Removal:	Pumping: Enhanced Evaporation: Extraction:	Liquids Pumps Enhanced Evaporation Extraction Wells (Vertical, Horizontal) Extraction Trenches Vacuum-Enhanced Extraction Wells
	Ex-Situ Treatment:	Biological Treatment: Thermal Treatment: Physical Treatment: Chemical Treatment:	Biological/PACT System Catalytic Oxidation Air Stripping Steam Stripping Membrane Filtration Ultrafiltration Granular Activated Carbon Adsorption Synthetic Resin Adsorption Cavitation Chemical Oxidation UV Oxidation Precipitation Ion Exchange
	Disposal / Discharge:	Disposal: Discharge:	Permitted TSD Facility POTW Dust Control / Irrigation On-site Ponds Reinjection

TABLE 8-4
REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS SUMMARY BY FS AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

STUDY AREA NO.	STUDY AREA	FS EVALUATION AREAS	CHEMICALS OF CONCERN	RISK CONSIDERATION	REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION	SUMMARY COMMENTS
2	PCB Landfill	**AREA 1**	--	GW protection HH risk Ecological-risk	• Prevent human exposures to risk-driving chemicals in surface water such that total carcinogenic risks are within the NCP risk range of 10^{-4} to 10^{-6} and noncancer hazard indices are less than 1. Potential human exposures include on-site worker, trespassers, and hypothetical offsite residents. • Prevent exposures to populations of ecological receptors for risk-driving chemicals in soil or sediment such that risks are below acceptable target levels (LOAEL HQ<1) • Mitigate potential groundwater contaminant migration	• No Action • RCRA-equivalent cap over BTA and CDA and RCRA cap over PCB landfill • Excavate impacted soils (metals) in BTA and CDA • Dispose in PCB Landfill or dispose offsite or treat onsite and place in PCB Landfill • Maintenance, Monitoring of cap, ICs, GW monitoring	• RCRA caps installed in previous site early actions satisfies RAOs. • No formal evaluation of the Capped Landfills study area is presented in the FS because Monitoring, Maintenance of cap, ICs, GW monitoring is a presumed remedial action intended to mitigate potential groundwater contaminant migration.
3	Burial Trench Area		Metals (Cr, Mo, Se, Zn, Va) in central and southern area VOCs (TCE) and other organics in shallow soil and residual NAPL in deep soil	Ecological-risk HH risk HH offsite GW protection			
4	Central Drainage Area		Metals (Cu) in western portion VOCs (MC, PCE, TCE, 1,1-DCA, 1,2-DCA) and other organics in western portion of area, south of P/S Landfill DNAPL, LNAPL (free phase NAPL present)	Ecological-risk HH risk HH offsite GW protection NAPL			
5	RCRA Canyon Area	**AREA 2**	Metals (Cr, Cu, Zn) in 0-5' bgs soil in most areas of northern and western slope of canyon. Some locations within impacted areas have deeper (>5' bgs) metals contamination in soil.	Ecological-risk GW protection	• Prevent exposures to populations of ecological receptors for risk-driving chemicals in soil or sediment such that risks are below acceptable target levels (LOAEL HQ<1)	• No Action • RCRA-equivalent cap or soil cap over impacted soil • Excavate impacted soil • Reuse impacted soil as fill with or without stabilization • Dispose in PCB Landfill with or without stabilization or offsite facility • Maintenance, Monitoring of cap, ICs	• Use ecological risk models and statistical analysis (95% UCL) of metals concentrations to formulate a risk-based remedial approach in the FS area.
6	West Canyon Spray Area		Metals (Cr, Cu, Zn) in shallow (0-5' bgs) in southern area, east slope of canyon				
7	Liquids Treatment Area	**AREA 3**	MCPP, DDT in surface soil Metals (Cu, Zn) in surface soil	HH risk Ecological-risk GW protection	• Prevent human exposures to risk-driving chemicals in surface water such that total carcinogenic risks are within the NCP risk range of 10^{-4} to 10^{-6} and noncancer hazard indices are less than 1 • Prevent exposures to populations of ecological receptors for risk-driving chemicals in soil or sediment such that risks are below acceptable target levels (LOAEL HQ<1) • Mitigate potential groundwater contaminant migration	• No Action • RCRA cap or asphalt cap • Excavate impacted hotspot soils and • Dispose in PCB Landfill or treat and reuse onsite or dispose offsite • RCRA cap over impacted soil • Maintenance, Monitoring of cap, ICs, GW monitoring	• The number of soil locations and extent of soils to be addressed by remedial alternatives will be based on exceedance of EcologicalRBCs or HHRBCs and the area-wide risk estimate. Use ecological risk models and statistical analysis (95% UCL) of COC concentrations to formulate a risk-based remedial approach in the FS area. • Excavation versus capping of impacted soil locations will be evaluated in this FS.
8	Maintenance Shed Area		Metals (Cd, Cr, Pb, Va), DDT in surface soil TPH-impacted soils (diesel, motor oil)	Ecological-risk HH risk GW protection			
10	Roadways		Metals (Cr, Zn, Cu) in soils	Ecological-risk GW protection			
11	Remaining Onsite Areas (Near SW ponds and SE portion of site)		Metals (Mo, Se) PAHs, PPCs, SVOCs in southern portion of site (RISBON-59 area)	HH risk (Pond B area) Ecological-risk HH offsite GW protection			
12	Former Pads and Ponds Subarea (areas south of PSCT not used for waste management)		Metals (Zn), PCBs, DDT PCE in soil (Pond A/B area)				

TABLE 8-4
REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS SUMMARY BY FS AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

STUDY AREA NO.	STUDY AREA	FS EVALUATION AREAS	CHEMICALS OF CONCERN	RISK CONSIDERATION	REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION	SUMMARY COMMENTS
14	Stormwater Ponds (RCF pond, A series ponds and Pond 13)	**AREA 4**	Metals (As), organics (PCBs, pesticides) in surface water Metals (Cd, Se, Cr, Zn), PCBs and pesticides in sediment	HH risk (surface water and sediment) Ecological-risk (sediment) GW protection	• Prevent human exposures to risk-driving chemicals in surface water such that total carcinogenic risks are within the NCP risk range of 10^{-4} to 10^{-6} and noncancer hazard indices are less than 1 • Prevent ecological exposures to risk-driving chemicals in surface water such that exposures are below acceptable levels (HQs <1 based on selected surface water benchmarks)	• No Action • ICs to prevent human contact with pond water • Liquids managed onsite and pumped to new evaporation pond • Capping sediment to control exposure and provide drainage • Excavate pond sediments • Dispose in PCB Landfill or offsite facility or treat and reuse as fill soil • Liquids treatment by mobile unit for offsite NPDES discharge • Discharge waste liquids offsite or to onsite evaporation ponds	• No Tier 2 risk evaluation conducted based on presumed pond closure, i.e. pumping of all stormwater and grading over the sediments. • Closure of existing ponds will likely require construction of new ponds to handle treated liquids and/or storm water.
15	Treated Liquid Impoundments (Ponds A-5, 18)		Metals (As) in surface water Metals (Cd, Cr, Cu, Se, Mo, Zn) in sediment	HH risk (surface water) Ecological-risk (sediment) GW protection			
--	Stormwater, Site-wide	**SITE-WIDE**	Metals, Organics	Potential offsite migration of onsite contaminants via stormwater and sediments	• Prevent human exposures to risk-driving chemicals in surface water such that total carcinogenic risks are within the NCP risk range of 10^{-4} to 10^{-6} and noncancer hazard indices are less than 1 • Prevent ecological exposures to risk-driving chemicals in surface water such that exposures are below acceptable levels (HQs <1 based on selected surface water benchmarks)	• Control onsite stormwater drainage and erosion to prevent impacted surface water or sediment migration offsite • Controls for stormwater sitewide including grading to control flow, use of detention basins, erosion controls, wetlands, etc. • Maintenance and monitoring of capped areas • Stormwater monitoring	• This was not a formal study area in the RI but is an overarching objective that touches on all site-wide soil study areas with the objective of controlling storm water flows and sediment migration to avoid potential exposures to onsite workers or ecological-receptors.
16	Groundwater - Northern Area (North of the PSCT)	**AREA 5 NORTH**	Dissolved VOCs, TPH, DNAPL at toe of P/S landfill Limited DNAPL in the CDA Residual NAPL in the BTA Metals (As, Ni, Cd, Se, Cu)	Groundwater protection DNAPL migration	• Restore groundwater quality to applicable standards (e.g. restore beneficial use, achieve MCLs) where technically practicable • Contain and/or control contamination sources within Zone 1 or subareas within Zone 1, where groundwater restoration to applicable standards is not technically practicable in those subareas. • Mitigate potential off-site migration of groundwater contamination by perimeter control • Remove DNAPL to the extent practicable and contain and/or control the migration of DNAPL where removal is not technically practicable. • Remove LNAPL to the extent practicable and contain and/or control the migration of LNAPL where removal is not technically practicable.	• No Action • Institutional Controls • Source control including continued extraction of liquids and DNAPL from onsite remedial features and source reduction by onsite capping or extraction • Perimeter extraction to prevent offsite contaminant migration • Passive treatment with in-situ chemical, physical, biological or thermal technologies to prevent offsite contaminant migration • DNAPL and LNAPL source removal with additional extraction wells in the vicinity of P/S Landfill or other technology to the extent practicable where significant reduction in risk will result. • Extracted groundwater treated by chemical, physical, biological or thermal technologies • Discharge to offsite TSDF, onsite ponds, offsite drainage, or reinjection • Groundwater Monitoring	• A request to grant a TI waiver for Area 5 North groundwater is included with this FS report.
16	Groundwater - Southern Areas (South of the PSCT)	**AREA 5 SOUTH**	Dissolved VOCs, TPH, Metals (As, Ni, Cd, Se, Cu)	Groundwater protection DNAPL migration	• Restore groundwater quality to applicable standards (e.g. restore beneficial use, achieve MCLs) where technically practicable • Contain and/or control contamination sources within Zone 1 or subareas within Zone 1, where groundwater restoration to applicable standards is not technically practicable in those subareas. • Mitigate potential off-site migration of	• No Action • Monitored Natural Attenuation • Institutional Controls • Source control including controlling leaching into groundwater by capping sources in soil or source reduction • Perimeter extraction to prevent offsite contaminant migration • Passive treatment with in-situ chemical, physical,	• Unlike Area 5 North, there is no TI waiver request for Area 5 South.

TABLE 8-4
REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS SUMMARY BY FS AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

STUDY AREA NO.	STUDY AREA	FS EVALUATION AREAS	CHEMICALS OF CONCERN	RISK CONSIDERATION	REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION	SUMMARY COMMENTS
					groundwater contamination by perimeter control	biological or thermal technologies to prevent offsite contaminant migration • Extracted groundwater treated by chemical, physical, biological or thermal technologies • Discharge to offsite TSDF, onsite ponds, offsite drainage, or reinjection • Groundwater Monitoring	
16	Groundwater – West (under RCRA Canyon and south of the Canyon)	**AREA 5 WEST**	Dissolved Metals (As, Ni, Cd, Se, Cu)	Groundwater protection DNAPL migration	• Restore groundwater quality to applicable standards (e.g. restore beneficial use, achieve MCLs) where technically practicable • Contain and/or control contamination sources within Zone 1 or subareas within Zone 1, where groundwater restoration to applicable standards is not technically practicable in those subareas. • Mitigate potential off-site migration of groundwater contamination by perimeter control	• No Action • Institutional Controls • Monitored Natural Attenuation • Extraction to prevent offsite contaminant migration • Passive treatment with in-situ chemical, physical, biological or thermal technologies to prevent offsite contaminant migration • Source control including controlling leaching into groundwater by capping of sources in soil • Extracted groundwater treated by chemical, physical, biological or thermal technologies • Discharge to offsite TSDF, onsite ponds, offsite drainage or reinjection • Groundwater Monitoring	• Unlike Area 5 North, there is no TI waiver request for Area 5 West.

NOTES

1. RAOs and GRAs are presented by study area. The study areas #1 through #15 are focused on soil contamination while study area #16 is related to groundwater.
2. Comments are provided in the rightmost column to provide additional perspective or explanation.
3. Those study areas that do not require evaluation in the FS are not included in this table.
4. Human receptors for onsite soil include onsite workers and trespassers and hypothetical offsite residents are included for onsite soil and offsite soil vapor.
5. Human receptors for groundwater and surface water include onsite workers and trespassers.
6. Table 8-5 presents the proposed stormwater benchmarks based on the higher of the 1999 NPDES levels, ecological-risk levels and background levels for adjacent site drainages for selected chemicals.
7. Chemicals of concern (COCs) are chemical of potential concern that were identified in the quantitative risk assessment as exceeding a risk threshold and warranting further evaluation in the Feasibility Study (FS). A human health and ecological risk assessment was completed to identify COCs. Two tiers of ecological risk assessments were conducted. The Tier 1 assessment identified two sets of chemicals (1) those requiring further evaluation in the Tier 2 assessment, for areas with no planned presumptive remedies, and (2) those considered COCs for areas with planned presumptive remedies based on the Tier 1 assessment, and not further evaluated in the Tier 2 assessment. The Tier 2 assessment identified COCs for areas with no planned presumptive remedies.

TABLE 8-5

THE PROPOSED NPDES STANDARDS FOR OFFSITE DISCHARGE OF TREATED STORMWATER, POND WATER OR TREATED GROUNDWATER

CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Parameter Name	1999 NPDES Standards (Revised 2004)	Casmalia Creek Surface Water (March 1998)[1]	A-Drainage Surface Water (RI data set)[1]	B-Drainage Wetlands Storm Water Discharge (2008-2012)[1]	C-Drainage Surface Water (RI data set)[1]	Ecological-Risk Level, HQ<1[2], Based On Aquatic Life[3] (Effect Level)	Source	Ecological-Risk Level, HQ<1[2], Based On Amphibians[4] (No-Effect Level)	Source	Proposed Standards
Aluminum, Total	1.0 mg/L	-	4.1 mg/L	-	100 mg/L	--	--	--	--	1.0 mg/L
Ammonia as N	0.25 mg/L	0.15 mg/L	--	-	-	--	--	--	--	0.25 mg/L
Antimony, Total	0.006 mg/L	ND	ND	-	0.044 mg/L	0.03 mg/L	Suter and Tsao, 1996; CVRWQCB, 2007	0.003 mg/L	Pauli et al., 2000[5]	0.006 mg/L
Arsenic, Total	0.050 mg/L	0.011 mg/L	0.0023 mg/L	-	0.019 mg/L	0.15 mg/L	USEPA, 2006a; USEPA, 2006b	0.0004 mg/L	Pauli et al., 2000[5]	0.050 mg/L
Barium	1.0 mg/L	0.070 mg/L	0.035 mg/L	0.6 mg/L	0.64 mg/L	0.004 mg/L	Suter and Tsao, 1996	0.0023 mg/L	Sparling et al., 2000[6]	1.0 mg/L
Beryllium, Total	0.004 mg/L	0.00033 mg/L	0.0001 mg/L	0.0036 mg/L	0.0047 mg/L	0.00066 mg/L	Suter and Tsao, 1996	0.000032 mg/L	Pauli et al., 2000[5]	0.004 mg/L
Boron	0.75 mg/L	-	-	-	-	--		--	--	0.75 mg/L
Cadmium, Total	0.003 mg/L	0.001 mg/L	0.00023 mg/L	0.0031 mg/L	0.0061 mg/L	0.003 mg/L	USEPA, 2006a	0.0000158 mg/L	Pauli et al., 2000[5]	0.003 mg/L
Chromium III	0.050 mg/L	-	-	-	-	0.250 mg/L	USEPA, 2006a	0.0003 mg/L	USEPA, 2007	0.050 mg/l
Chromium VI	0.0114 mg/L	-	-	-	-	--	--	--		0.0114 mg/L
Chromium, Total	0.050 mg/L	0.01800 mg/L	ND	0.150 mg/L	0.24 mg/L	0.250 mg/L	USEPA, 2006a	0.0003 mg/L	USEPA, 2007	0.050 mg/L
Cobalt, Total	0.050 mg/L	ND	ND	0.020 mg/L	0.013 mg/L	0.023 mg/L	Suter and Tsao, 1996	0.0005 mg/L	Pauli et al., 2000[5]	0.050 mg/L
Copper, Total	0.030 mg/L	ND	0.032 mg/L	0.056 mg/L	0.11 mg/L	0.013 mg/L	USEPA, 2006a	0.00001 mg/L	Sparling et al., 2000[6]	0.030 mg/L
Fluoride	1.0 mg/L	-	-	-	-	--	--	--	--	1.0 mg/L
Iron, Total	0.300 mg/L	6.41 mg/L	4.0 mg/L	-	130 mg/L	--	--	--	--	0.300 mg/L
Lead, Total	0.015 mg/L	0.0075 mg/L	0.00086 mg/L	-	0.034 mg/L	0.0039 mg/L	USEPA, 2006a; USEPA, 2006b	0.0004 mg/L	USEPA, 2007	0.015 mg/L
Lithium	2.5 mg/L	-	-	-	-	--		--	--	2.5 mg/L
Manganese, Total	0.050 mg/L	0.441 mg/L	0.031 mg/L	-	0.71 mg/L	0.12 mg/L	Suter and Tsao, 1996	0.0005 mg/L	Sparling et al., 2000[6]	0.050 mg/L
MBAS	0.200 mg/L	0.08 mg/L	-	-	-	--	--	--	--	0.200 mg/L
Mercury, Total	0.00005 mg/L	ND	ND	0.0001 mg/L	0.00012 mg/L	0.00077 mg/L	USEPA, 2006b	0.00001 mg/L	USEPA, 2007	0.00005 mg/L
Molybdenum, Total	0.010 mg/L	0.05400 mg/L	ND	0.032 mg/L	0.027 mg/L	0.370 mg/L	Suter and Tsao, 1996	0.0004 mg/L	Sparling et al., 2000[6]	0.010 mg/L
Nickel, Total	0.100 mg/L	0.028 mg/L	0.013 mg/L	0.180 mg/L	0.23 mg/L	0.073 mg/L	USEPA, 2006a; USEPA, 2006b	0.00002 mg/L	Pauli et al., 2000[5]	0.100 mg/L
Nitrate (as NO_3)	45 mg/L	-	-	-	-	--	--	--	--	45 mg/L
Nitrate + Nitrite (as N)	10 mg/L	-	-	-	-	--	--	--	--	10 mg/L

TABLE 8-5

THE PROPOSED NPDES STANDARDS FOR OFFSITE DISCHARGE OF TREATED STORMWATER, POND WATER OR TREATED GROUNDWATER

CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Parameter Name	1999 NPDES Standards (Revised 2004)	Casmalia Creek Surface Water (March 1998)[1]	A-Drainage Surface Water (RI data set)[1]	B-Drainage Wetlands Storm Water Discharge (2008-2012)[1]	C-Drainage Surface Water (RI data set)[1]	Ecological-Risk Level, HQ<1[2], Based On Aquatic Life[3] (Effect Level)	Source	Ecological-Risk Level, HQ<1[2], Based On Amphibians[4] (No-Effect Level)	Source	Proposed Standards
Nitrite (as N)	1.0 mg/L	-	-	-	-	--	--			1.0 mg/L
Selenium, Total recoverable	0.005 mg/L	0.019 mg/L	-	0.044 mg/L	-	0.005 mg/L	USEPA, 2006a; USEPA, 2006b	0.0009 mg/L	USEPA, 2007	0.005 mg/L
Silver, Total	0.100 mg/L	ND	ND	-	0.00053 mg/L	0.00036 mg/L	Suter and Tsao, 1996	0.000041 mg/L	Pauli et al., 2000[5]	0.100 mg/L
Sulfate	250 mg/L	-	-	-	-	--	--	--	--	250 mg/L
Thallium, Total	0.002 mg/L	ND	ND	-	0.0016 mg/L	0.012 mg/L	Suter and Tsao, 1996	0.0001 mg/L	Sparling et al., 2000[6]	0.002 mg/L
Vanadium, Total	0.100 mg/L	0.05700 mg/L	ND	-	0.23 mg/L	0.020 mg/L	Suter and Tsao, 1996	0.00003 mg/L	Sparling et al., 2000[6]	0.100 mg/L
Zinc, Total	0.200 mg/L	0.026 mg/L	0.01 mg/L	0.230 mg/L	0.28 mg/L	0.17 mg/L	USEPA, 2006a; USEPA, 2006b	0.000047 mg/L	Pauli et al., 2000[5]	0.200 mg/L
Biochemical Oxygen Demand	-	-	-	44 mg/L O_2	-	--	--	--	--	-
Chemical Oxygen Demand	-	-	-	190 mg/L O_2	-	--	--	--	--	-
Total Suspended Solids	-	226 mg/L	-	3,100 mg/L	-	--	--	--	--	-
Total Dissolved Solids	1,000 mg/L	2,200 mg/L	-	3,200 mg/L	-	--	--	--	--	1,000 mg/L
Hardness (as $CaCO_3$)	-	808 mg/L	-	-	-	--	--	--	--	-
Odor	3 threshold units	45.00	-	-	-	--	--	--	--	3 threshold units
Oil and Grease	-	-	-	-	-	--	--	--	--	-
pH	-	8.42 s.u.	-	7.69 s.u.	-	--	--	--	--	-

General Notes:

1 The selected standards are preliminary and subject to RWQCB review and approval.

2 The proposed standards reflect the 1999 NPDES Standard (revised 2004) while the background concentrations measured in the A-, B-, and C-drainages and the Ecological-risk levels are provided for comparison purposes.

Specific Notes:

1 Analyte concentrations represent maximum values reported for each of the indicated surface water sampling efforts ("-" indicates not available or not analyzed)

2 Ecological-Risk Level based on the surface water screening levels presented in Table U-24 of the Final Remedial Investigation (RI) Report (CSC, 2011). (-- indicates parameter was not evaluated in the risk assessment)

3 Preference in selecting surface water screening levels was given to promulgated numeric water quality criteria for priority toxic pollutants and other water quality standards provisions for the waters in the State of California. Chronic effects values were selected, where available, from the following hierarchy of sources: United States Environmental Protection Agency (USEPA) Federal Register Title 40 CFR Part 131 Water Quality Standards Section 38-Established Numeric Criteria for Priority Toxic Pollutants for the State of California (USEPA, 2006a), USEPA National Ambient Water Quality Criteria (USEPA, 2006b), Oak Ridge National Laboratory: Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota (Suter and Tsao, 1996), USEPA Supplemental Guidance to Risk Assessment Guidance: Region 4 Bulletins, Ecological Risk Assessment (USEPA, 2001), San Francisco Regional Water Quality Control Board (SFRWQCB) ESLs: Freshwater Aquatic Habitat Goals (SFRWQCB, 2005), Central Valley Regional Water Quality Control Board (CVRWQCB) Recommended Numerical Limits to Translate Water Quality Objectives (CVRWQCB, 2007), and Water Management Policies Guidelines Provincial Water Quality Objectives of the Ontario Ministry of Environment and Energy (MOEE,1999 revision).

4 Selected based on the lowest no-effect value (protective of sensitive species) of the empirical data cited in Ecotoxicology of Amphibians and Reptiles (Sparling et al., 2000), empirical data from the Database of Reptile and Amphibian Toxicology Literature (RATL) (Pauli et al. 2000), and empirical data from the ECOTOX database (USEPA, 2007). Uncertainty factors were used to extrapolate to no-effect levels, when only effect-levels were available.

5 LC50 value from Pauli et al. (2000) / Uncertainty Factor of 100.

6 LC10 value from Sparling et. al. (2000)/ Uncertainty Factor of 10.

ND Not Detected

mg/L Milligrams per liter

mg/L O_2 Milligrams of oxygen consumed per liter

s.u. Standard pH units

TABLE 8-5

THE PROPOSED NPDES STANDARDS FOR OFFSITE DISCHARGE OF TREATED STORMWATER, POND WATER OR TREATED GROUNDWATER

CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

References:

CSC. 2011. Final Remedial Investigation Report. Casmalia Resources Superfund Site. Casmalia Steering Committee. January.

CVRWQCB. 2007. *Recommended Numerical Limits to Translate Water Quality Objectives.* Summary of: A Compilation of Water Quality Goals. Central Valley Regional Water Quality Control Board Cal EPA, August 2003. 186 pp. Available at: http://www.swrcb.ca.gov/rwqcb5/available_documents/index.html#WaterQualityGoals

Pauli, B.D., J.A. Perrault and S.L. Money. 2000. RATL: A Database of Reptile and Amphibian Toxicology Literature. Technical Report Series No. 357.Canadian Wildlife Service, Headquarters, Hull, Québec, Canada.

Sparling, D.W., G. Linder, and C.A. Bishop, 2000.*Ecotoxicology of Amphibians and Reptiles*.SETAC Technical Publication Series.

Suter II, G. W. and C. L. Tsao, 1996.*Toxicological Benchmarks for Screening PotentialContaminants of Concern for Effects on Aquatic Biota: 1996 Revision*. Oak Ridge National Laboratory, June.

USEPA.2006a. Water Quality Standards, Establishment of Numeric Criteria for Priority Pollutants for the State of California. 40 CFR Part 131 Section 38. pp. 1-39. April 2000, updated Dec 2006.

USEPA, 2006b.National Recommended Water Quality Criteria.U.S. Environmental Protection Agency Office of Water.Washington, D.C. 25 pp.
USEPA.2007a. ECOTOX database. U.S. Environmental Protection Agency Website updated daily: http://cfpub.epa.gov/ecotox/

Table 8-6a
Ecological Chemicals of Concern and Risk-Based Concentrations in Soil
Casmalia Resources Superfund Site Final Feasibility Study

	Terrestrial Invertivorous Mammal				Terrestrial Herbivorous Mammal				Terrestrial Carnivorous Mammal				Terrestrial Invertivorous Bird			
	Ornate Shrew				California Vole				Striped Skunk				Western Meadowlark			
Chemicals of Concern[1]	Highest LOAEL/high TRV-based HQ	Study Area	Surface and shallow soil EPC (0-5.5 ft bgs; mg/kg)	RBC	Highest LOAEL/high TRV-based HQ	Study Area	Surface and shallow soil EPC (0-5.5 ft bgs; mg/kg)	RBC	Highest LOAEL/high TRV-based HQ	Study Area	Surface and shallow soil EPC (0-5.5 ft bgs; mg/kg)	RBC	Highest LOAEL/high TRV-based HQ	Study Area	Surface soil EPC (0-0.5 bgs; mg/kg)	RBC
Chromium	1.0	West Canyon Spray Area	206	204	0.1	West Canyon Spray Area	206	1442	0.1	West Canyon Spray Area	206	1825.4	8.0	West Canyon Spray Area	590.6	74
Copper	20.0	West Canyon Spray Area	271	14	2.5	West Canyon Spray Area	271	107	1.9	West Canyon Spray Area	271	143.1	18.1	West Canyon Spray Area	461.0	25
Zinc	0.5	RCRA Canyon	176	353	0.1	RCRA Canyon	176	3067	0.1	RCRA Canyon	176	2944.8	1.5	RCRA Canyon	292.9	191

	Terrestrial Herbivorous Bird				Terrestrial Carnivorous Bird				Terrestrial Plants[3]				Soil invertebrates[2]			
	Western Meadowlark				American Kestrel											
Chemicals of Concern[1]	Highest LOAEL/high TRV-based HQ	Study Area	Surface soil EPC (0-0.5 bgs; mg/kg)	RBC	Highest LOAEL/high TRV-based HQ	Study Area	Surface soil EPC (0-0.5 bgs; mg/kg)	RBC	Highest HQ	Study Area	Surface and shallow soil EPC (0-5.5 ft bgs; mg/kg)	RBC	Highest HQ	Study Area	Surface soil EPC (0-0.5 bgs; mg/kg)	RBC
Chromium	7.6	West Canyon Spray Area	591	78	0.8	West Canyon Spray Area	591	724	206.3	West Canyon Spray Area	206	1.0	1477	West Canyon Spray Area	591	0.4
Copper	6.6	West Canyon Spray Area	461	70	8.1	West Canyon Spray Area	461	57	3.9	West Canyon Spray Area	271	70	6	West Canyon Spray Area	461	80
Zinc	0.4	RCRA Canyon	293	667	0.8	RCRA Canyon	293	358	3.5	RCRA Canyon	176	50	2.9	RCRA Canyon	293	100

Notes:

Selected surface and shallow soil ecological risk-based concentration for 0-5.5 feet bgs interval.

Selected surface soil ecological risk-based concentration for 0-0.5 foot bgs interval.

bgs = below ground surface
EPC = exposure point concentration; based on the 95% upper confidence limit (UCL) of the mean or maximum detected concentration (presented in Attachments 5 and 5A of Appendix U of the ERA (CSC 2011).
ERA = ecological risk assessment
HQ = hazard quotient (unitless)
LOAEL = lowest observed adverse effect level
mg/kg = milligrams per kilogram
Eco RBC = ecological risk-based concentration
NA = not applicable
TRV = toxicity reference value
1. Ecological RBCs identified based on the results of the Tier 2 ERA (CSC 2011) and were not derived for the American badger as the risk-driving chemicals were not detected in deep soils (5.5-10 feet bgs).

Reference:

Casmalia Steering Committee (CSC). 2011. Final Remedial Investigation Report. January.

Table 8-6b
Human Health Chemicals of Concern and Risk-Based Concentrations in Soil
Commercial/Industrial Worker
Casmalia Resources Superfund Site Final Feasibility Study

Chemicals of Concern	HH RBC (mg/kg) Target Risk = 1 x 10^{-5}	HH RBC (mg/kg) Target Hazard Quotient = 1
Organics		
MCPP	NA	770
TCE	50	76
PCE	11	120

Selected surface and shallow soil (0 to 5.5 feet bgs) risk-based concentration (RBC)

bgs = below ground surface
HH RBC = human health risk-based concentration
mg/kg = milligram per kilogram
MCPP = 2-(2-chloro-4-methylphenoxyl) propionic acid
NA = not applicable
PCE = tetrachloroethene
TCE = trichloroethene

Table 8-6c
Preliminary Remediation Goals for Chemicals of Concern in Soil
Casmalia Resources Superfund Site Final Feasibility Study

Chemicals of Concern	Ecological RBC (mg/kg)		Human Health RBC (mg/kg)		Background[e] (mg/kg)	Preliminary Remediation Goals (mg/kg)	
	Surface Soil[a]	Subsurface Soil[b]				Surface Soil[a]	Subsurface Soil[b]
Ecological							
Chromium	74	204	--		47	74	204
Copper	25	14	--		19	25	19
Zinc	191	353	--		104	191	353
Human Health							
MCPP	--	--	770	c	NA	770	770
TCE	--	--	50	d	NA	50	50
PCE	--	--	11	d	NA	11	11

Notes:
a. Selected surface soil ecologcial risk-based concentration for 0-0.5 foot bgs (see Table 8-6a).
b. Selected surface and shallow soil ecologcial risk-based concentration for 0-5.5 feet bgs (see Table 8-6a).
c. Target hazard quotient = 1 (see Table 8-6b).
d. Target risk = 1×10^{-5} (see Table 8-6b).
e. Based on the upper threshold limit using site-specific data (CSC 2011).
f. Based on higher of the background (if available) and the RBC.

-- = not applicable (not a chemcial of concern for these receptors)
bgs = below ground surface
Ecological RBC = ecological risk-based concentration
HH RBC = human health risk-based concentration
MCPP = 2-(2-chloro-4-methylphenoxyl) propionic acid
mg/kg = milligram per kilogram
NA = not avaialble
PCE = tetrachloroethene
TCE = trichloroethene

Reference:
CSC, 2011. Final Remedial Investigation Report, January 2011.

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
NO ACTION	None	Not Applicable	No Action.	Required for consideration by NCP
INSTITUTIONAL CONTROLS	Access Restrictions	Restrictive Covenants (deed restrictions)	Legal/administrative control applied to property to control land or resource use in area of influence to minimize potential for human exposure.	Potentially applicable
	Land Use Restrictions	Zoning Restrictions	Administrative control applied to the general area to control land or resource use.	Potentially applicable in combination with other process options
	Groundwater Use Restrictions	Restrictive covenant	Legal/administrative control applied to property to include restrictions on use of groundwater wells.	Potentially applicable
	Permitting	Building/Grading permits	Administrative control applied to property to control development in area of influence.	Not applicable because this property is not proposed for redevelopment
	Alternate Water Supply	Zoning Restrictions	Administrative control applied to the general area to control land or resource use.	Not applicable because there are no offsite impacts to groundwater as a result of site activities
	Informational Tools	Fact Sheet / Press Release/ Web-based	Administrative control used to provide information that helps modify use of the property.	Potentially applicable in combination with other technologies
	Monitoring	Groundwater monitoring	Ongoing monitoring of groundwater wells to monitor plume.	Potentially applicable for onsite and offsite wells
	Monitoring	Soil Vapor monitoring	Ongoing monitoring of soil vapor points.	Potentially applicable for onsite soil vapor points
SOIL/SEDIMENT				
CONTAINMENT	Caps	Clay and Soil	Compacted soils with clay engineered for low permeability and covered with soil/vegetation over contamination areas.	Potentially applicable
		Evapotranspiration (ET) covers	Lightly compacted soil covers designed with vegetative layers intended to prevent moisture from migrating to contamination or waste below by transpiration and evaporation processes.	Potentially applicable
		Asphalt	Installation of asphalt cover over contaminated areas.	Potentially applicable
		Concrete	Installation of concrete slab over contaminated areas.	Potentially applicable
		Multilayer RCRA or RCRA-equivalent	Rigorously engineered complex cap with layers of clay and geotextile liners/membranes, permeable materials, and soil/ vegetation cover over contaminated areas.	Potentially applicable
		Pond liner – for stormwater or treated groundwater	An engineered single or multilayer HDPE membrane system that includes a drainage layer that drains any leaks to leachate collection and removal system and leak detection system.	Potentially applicable

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
	Horizontal Barriers	Vapor Barriers for building foundations	Combination of clay/geotextile liner barrier below building to control vapor migration.	Not applicable. No future site redevelopment or building construction is planned
CONTAINMENT	Building Pressurization	HVAC Modification	Building pressurization including surface sealing to contain subsurface vapor intrusion.	Not applicable because no future site redevelopment or building construction is planned.
	Subslab Venting	Passive Venting	Venting beneath building foundation slabs for extraction of VOC soil vapors.	Not applicable. No future site redevelopment or building construction is planned
		Active Venting	Venting beneath building foundation slabs for vacuum extraction of VOC soil vapors.	Not applicable. No future site redevelopment or building construction is planned
	Erosion Controls	Geomats	Water permeable polymer or other synthetic material used to fix/stabilize soil elements, grass and small roots to control wind and water erosion, especially in sloped areas.	Potentially applicable
EXCAVATION	Excavation	Conventional excavation	Excavation with backhoes and excavators with sloped sidewalls.	Potentially applicable
		Shoring	Excavation where shoring is used to retain vertical sidewalls for construction of a trench.	Potentially applicable
		Large diameter auger excavation	Large diameter augers are used in excavation for removing deep soil contamination. Excavation of an area is conducted by numerous closely spaced boreholes about 3 to 4 feet diameter.	Not applicable because trench based excavation has been shown to be effective at this site for deep excavation. Will be significantly higher in cost compared to trench based excavation.
DISPOSAL/REUSE	Onsite Disposal	Onsite landfill disposal	Disposal of impacted soils and other waste in the onsite PCB landfill or as backfill in other areas of the site (e.g. under a cap or for pond closure).	Potentially applicable
	Offsite Disposal	Offsite Facility	Disposal at offsite landfill or other TSDF facility.	Potentially applicable for certain select wastes that cannot be landfilled onsite
EXCAVATION/TREATMENT	Ex-situ Treatment	Bioremediation/Landfarming	Introducing bacteria and nutrients to degrade biodegradable contaminants in soil.	Potentially applicable for petroleum contaminants, not for metals
		Soil Vapor Extraction in soil piles	Extracting soil vapor by applying vacuum and treating extracted soil vapor before discharge.	Potentially applicable for VOC contaminants only
		Onsite Stabilization	Excavated soils are mixed with inorganic binders such as cement or pozzolans to form stabilized concrete blocks which can then be landfilled.	Potentially applicable for non-VOC contaminants only such as metals-impacted soils.

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
		Soil/Solvent Washing	Soil washing with water/solvent to dissolve contaminants in soil followed by treatment of contaminated water.	Not retained because of the very high cost of onsite soil treatment ($150 to 200/ton) when onsite and offsite borrow soil is available at $6/cy and offsite disposal is approximately $80/ton for non-RCRA hazardous soil. Also, limited applicability for onsite soil conditions (claystone) which would require expensive pre-processing prior to soil treatment. Generally this technology is not widely used and has very limited technology vendors. Known technology vendors are out of business.
		Chemical Oxidation/Reduction	Introduction of chemical agents to treat soil by chemical reactions to treat oxidize or reduce contaminant to innocuous byproducts.	Not retained because of the very high cost of onsite soil treatment ($150 to $200/ton) when onsite and offsite clean borrow soil is available at $6/cy and offsite disposal is approximately $80/ton for non-RCRA hazardous soil. Also, limited applicability for onsite soil conditions (claystone) which would require expensive pre-processing prior to soil treatment. Not as proven as thermal desorption VOCs and other organics.
		Thermal Desorption	Thermally enhanced soil vapor extraction. Soil is heated to volatilize contaminants such as VOCs, PCBs, PAHs, and pesticides.	Potentially applicable for VOCs, PCBs, PAHs and pesticides. Not for metals. Unit cost is high in the range of $150 to $200/ton. Treatment of claystone material is challenging and will require pre-treatment that could increase costs and/or lower treatment efficiency. Retained as a representative ex-situ treatment option if needed.
IN-SITU TREATMENT	In Situ Treatment Systems	Soil Vapor Extraction	Extracting soil vapor by applying vacuum to vapor extraction wells and treating vapors in aboveground activated carbon or thermal oxidizer system. Primarily applicable to VOC contaminants in soil.	Potentially applicable
		In Situ Bioventing	Injecting/extracting air into the subsurface through bioventing wells to biodegrade contaminants in soil using naturally existing soil microbes.	Not retained for site contaminants (mixed chlorinated solvents and petroleum hydrocarbons) and site conditions including fractured bedrock lithology which will result in preferential air flow along fractures but not result in degradation of contaminants within the matrix. No known history of use of this technology in fractured bedrock conditions in the vadose zone.
		In Situ Soil Flushing	Injection of solvent into the subsurface to dissolve contaminants with subsequent removal of dissolved contaminants in groundwater by extraction wells and aboveground treatment.	Not retained for site contaminants (mixed chlorinated solvents and petroleum hydrocarbons) and conditions including fractured bedrock lithology which will result in preferential flow of the flushing solvent through fractures without cleanup of the contaminants in the matrix. In addition, there is the potential for migration of contaminants in the saturated zone where effective capture in the claystone formation is challenging. No known history of use of this technology in fractured bedrock conditions in the vadose zone.
		In-Situ Thermal Desorption	Subsurface soil is heated with thermal blankets / wells and SVE wells used to extract contaminated vapors for aboveground treatment.	Potentially applicable but limitations anticipated with effective vapor recovery of heated soil vapors within the fractured bedrock and weathered claystone lithology.
		In-Situ Electric Resistance Heating	Subsurface soil is heated by passing current through electrodes placed in the soil, typically in the saturated zone. SVE wells are used to extract and treat vapors.	Potentially applicable though ISTD would be more effective in the vadose zone than ERH which requires adequate moisture in the vadose zone to transmit electricity and heat the soils.

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
		In Situ Steam Injection	Subsurface soil is heated by injecting steam to volatilize contaminants. Vapors are removed by SVE and treated in an aboveground system.	Not retained due to site lithology that includes fractured bedrock conditions that would result in steam flow in preferred pathways along fractures and uneven heating and challenges with capture of the vapors. ISTD and ERH are retained as representative thermal technologies.
GROUNDWATER				
CONTAINMENT	Impermeable Vertical Barriers	Soil-Bentonite or Cement slurry wall	Soil-bentonite or Cement slurry placed in a narrow trenches tied down to a clay or low permeability zone.	Potentially applicable
		Clay barrier	Low permeability clay soils placed in a narrow trenches tied down to a clay or low permeability zone.	Potentially applicable
		Grout injection	Pressure injection of grout through closely spaced grid of injection points to form a low permeability grout curtain.	Not retained because it is not as effective in this fractured bedrock formation and higher in cost than the clay barriers that have already been implemented at the site.
	Horizontal Barriers, Soil Caps	Clay, Multilayer cap, asphalt, concrete	Horizontal barriers (discussed earlier under soil technologies) decrease surface or stormwater infiltration into groundwater thereby limiting further migration of groundwater contaminants.	Potentially applicable
	Hydraulic Controls	Extraction and Injection wells	Creating a hydraulic barrier by extraction and reinjection wells that prevents contaminant migration out of containment zone or extraction alone to serve as hydraulic control of contaminated groundwater.	Potentially applicable
		Phytoremediation	Use of plants and trees as a containment approach to extract contaminated groundwater and help with hydraulic control of contaminated groundwater. Phytoremediation can also be used to remediate or stabilize contaminants in vadose zone soil, sediments and surface water.	Potentially applicable
IN-SITU TREATMENT	Passive In-situ Treatment	Monitored Natural Attenuation	Reduction of dissolved concentrations through naturally occurring processes such as dilution, volatilization, biodegradation, or adsorption. Long term groundwater monitoring would be required.	Potentially applicable
		Permeable Reactive Barriers Reactive Walls	Installation of permeable barriers in the subsurface across the direction of groundwater flow to passively treat VOCs and metals contamination typically using deep trenches. Zero valent iron is used to treat chlorinated solvents by chemical reduction in reactive barriers.	Potentially applicable. Injection-based reactive barriers are not considered viable in this subsurface lithology.
	Active In-situ treatment	Air Sparging	Injection of compressed air through injection wells to strip and biodegrade hydrocarbons with volatiles captured in vadose zone by soil vapor extraction.	Potentially applicable.

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
		Biosparging	Low flow air injection without volatilization and without the need for SVE; typically implemented in the dissolved plume and not within NAPL source.	Not applicable for site contaminants (mixed chlorinated solvents and petroleum hydrocarbons) and site conditions including fractured bedrock lithology which will result in preferential air or other injectate flow along fractures but not result in degradation of contaminants within the matrix.
		In-situ Thermal Desorption	ISTD is a thermally enhanced SVE that involves heating soil using thermal wells that use resistive heating elements with associated SVE to remove volatilized contaminants.	Potentially applicable but limitations anticipated with effective vapor recovery with the fractured bedrock and weathered claystone lithology.
		Electric Resistance Heating	Soil is heated to about 200°F (near boiling point of water) by passing a current directly through soil using electrodes placed in soil and using SVE to collect and treat vapors in aboveground systems.	Potentially applicable
		Steam Injection	Steam is injected in wells to heat the subsurface and volatilize contaminants by boiling the water in the saturated zone. Vapors and NAPL are removed by vacuum extraction and treated in aboveground systems.	Not retained due to site lithology that includes fractured bedrock conditions that would result in steam flow in preferred pathways along fractures and uneven heating and challenges with capture of the vapors. ISTD and ERH are retained as representative thermal technologies.
		In-situ Soil Mixing	Using large diameter augers to mix in reactive reagents to reduce, oxidize, destroy or stabilize contaminants in place. Has been used in applications for small well-defined NAPL source areas including chlorinated solvents DNAPL areas.	Not retained due to fractured bedrock conditions which would make mixing reagents difficult and poor in effectiveness and degrading contaminants.
		In-situ Aerobic Bioremediation	Direct injection or placement in permeable reactive barriers of oxygen/nutrients/microbes to enhance in-situ bioremediation of petroleum hydrocarbon VOCs.	Not retained due to the nature of contaminants (mixture of chlorinated solvents, petroleum hydrocarbons, metals) and fractured bedrock conditions that would make injected reagents travel through preferential pathways and not degrade contaminants inside the matrix. Placement in PRBs would be better than direct injection but is limited in effectiveness due to mixed contaminants and high costs of frequent replacement of these barriers.
		In-situ Anaerobic Bioremediation Includes Bioaugmentation, Biostimulation	Direct injection of substrates/nutrients/microbes or placement in reactive barriers to enhance in-situ bioremediation of VOCs, solvents and other hydrocarbons.	Potentially applicable in reactive barriers though challenges are anticipated with mixed contaminants and clogging of the PRBs with high TDS and metals in groundwater.
		In-situ Chemical Oxidation	Strongly oxidizing chemicals (such as Ozone, H_2O_2, $KMnO_4$) are injected into the subsurface to oxidize NAPL or dissolved hydrocarbons in-situ to innocuous byproducts.	Potentially applicable though challenges anticipated with mixed contaminants and high TDS which would result in high oxidant demand and thus less cost effective.
		In-situ Chemical Reduction	Direct injection or placement in reactive barriers or funnel and gate applications of reducing reagents such as zero valent iron (ZVI) to reduce chlorinated solvents or metals without groundwater extraction.	Potentially applicable as PRBs though challenges are anticipated with multiple contaminants (chlorinated solvents, petroleum hydrocarbons, metals)

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
		In-situ Soil Flushing	Injection of solvent into the subsurface to enhance dissolution of contaminants and subsequent removal by groundwater extraction and treatment.	Not retained for site contaminants (mixed chlorinated solvents and petroleum hydrocarbons) and conditions including fractured bedrock lithology which will result in preferential flow of the flushing solvent through fractures without cleanup of the contaminants in the matrix. In addition, there is the potential for migration of contaminants in the saturated zone where effective capture in the claystone formation is challenging.
		Hydraulic fracturing enhancements	Injection of pressurized fluid or air to produce fractures and increase soil permeability. Used as a supplement to enhance performance of other technologies in low permeability media.	Not applicable due to uneven fracturing of the subsurface and very high costs. Known to be used on limited small areas of injection. Not cost effective for large area applications such as this site.
EXTRACTION/DISCHARGE	Extraction	Extraction wells (Vertical)	Series of wells to extract impacted groundwater as part of hydraulic control or extract NAPL as source control to limit contaminant migration. They can be used to remove LNAPL and DNAPL mass from the subsurface, hydraulically control LNAPL migration, and partially control DNAPL migration.	Potentially applicable for both extracting groundwater and also to selectively extract NAPL. Hydraulic control of DNAPL is only partially effective because DNAPL migration is density driven and only partially influenced by hydraulic gradients. Removal of the mobile DNAPL source is necessary to control DNAPL migration.
		Extraction trenches	Series of trenches to extract impacted groundwater as part of hydraulic control or source control to ensure DNAPL or dissolved contaminant migration is limited. They can be used to remove LNAPL and DNAPL mass from the subsurface, hydraulically control LNAPL migration, and partially control DNAPL migration.	Potentially applicable. Hydraulic control of DNAPL is only partially effective because DNAPL migration is density driven and only partially influenced by hydraulic gradients. Removal of the mobile DNAPL source is necessary to control DNAPL migration.
		Horizontal wells	Horizontal well or wells to extract impacted groundwater as part of hydraulic control or extract NAPL as source control to ensure DNAPL or dissolved contaminant migration is limited. They can be used to remove LNAPL and DNAPL mass from the subsurface, hydraulically control LNAPL migration, and partially control DNAPL migration.	Potentially applicable. Hydraulic control of DNAPL is only partially effective because DNAPL migration is density driven and only partially influenced by hydraulic gradients. Removal of the mobile DNAPL source is necessary to control DNAPL migration.
EXTRACTION/TREATMENT	Ex-situ Treatment	NAPL skimmers	Active or passive skimmers are placed in groundwater wells to remove any accumulating free product for collection in a tank and offsite disposal. Applicable for LNAPL and DNAPL.	Potentially applicable for DNAPL and LNAPL skimming.
		Hydraulic Extraction Pump and Treat	Groundwater is extracted from subsurface wells creating a sufficient hydraulic gradient to mobilize NAPL. The recovered NAPL is destroyed or recycled, and groundwater is treated in aboveground equipment and discharged.	Potentially applicable

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
		Dual-Phase Extraction Multi-Phase Extraction	High vacuum (>20-inch Hg) is applied to subsurface wells to remove vapors, groundwater and NAPL which are treated aboveground. When the water table is deep, groundwater extraction pumps may be required for liquids extraction.	Potentially applicable
		Enhanced NAPL Recovery	Flushing with solvents (incl. water), surfactants and other chemicals to dissolve or alter the physical properties of the NAPL to make it more easily extractable. This could be potentially applicable for LNAPL or DNAPL. An example of an application for a DNAPL extraction is called "waterflood oil recovery" approach. Key to optimizing DNAPL extraction with this approach is maintaining maximum DNAPL saturation. Also, this technology has been utilized primarily in aquifers that have high conductivity such as alluvial aquifers.	Potentially applicable but significant concerns with applicability in the lithology at this site which includes a low permeability ($1x10^{-5}$ cm/s) weathered claystone underlain by very low permeability ($1x10^{-6}$ cm/s) fractured bedrock.
WATER TREATMENT				
EX-SITU WATER TREATMENT	Aboveground Water Treatment Systems	Liquid Phase Granular Activated Carbon (LPGAC) Powdered Activated Carbon (PAC)	LPGAC in a series of vessels to adsorb dissolved organic contamination in groundwater. Powdered activated carbon is used effectively in wastewater treatment and also for leachate treatment applications at landfills.	Potentially applicable
		Synthetic resin Macroporous Polymer Extraction (MPPE)	Synthetic resins or polymeric beads to adsorb dissolved organic contamination in groundwater. MPPE uses an extraction medium embedded in polymeric beads to remove hydrocarbons from water.	Potentially applicable
		Air stripper	VOCs are stripped from extracted groundwater using air injection from a blower. Air strippers can be in a packed bed or a parallel tray configuration.	Potentially applicable
		Chemical oxidation/Advanced oxidation	Using injected oxidant chemicals such as peroxide or ozone in piping or reactors to oxidize organics to innocuous byproducts.	Potentially applicable
		Bioreactors	Bioreactors involved treatment of influent water with aerobic or anaerobic biodegradation including addition of microbes and nutrients and the use of media for growth of microbes. Fixed film or fluidized bed bioreactors are examples. Bio-PACT is an example of a combined bioreactor and activated carbon system.	Potentially applicable
		Chemical reduction/precipitation - Ferrous solutions ($FeSO_4$) - Ferric chloride (FeCl3)	Using chemicals such as ferrous sulfate to reduce and precipitate metals or ferric chloride to precipitate low levels of metals in groundwater.	Potentially applicable especially using those reagents (e.g. ferric chloride) that can precipitate low levels of metals.
		Ion Exchange	Ion exchange resins adsorb anions or cations in groundwater to remove metals and other contaminants.	Potentially applicable

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
		Reverse Osmosis	Uses high pressure to push contaminated water through a semipermeable membrane that allows water to pass through but does not allow the contaminants such as dissolved metals or other inorganics to pass through.	Potentially applicable
		Membrane filtration (e.g. VSEP)	Uses membranes with nano or microfiltration techniques to remove fine particulate metal, inorganics or other contamination. E.g. Vibratory Shear Enhanced Process (VSEP).	Potentially applicable
		Oil-Water separator	Using oil-water separators to remove any extracted LNAPL or DNAPL prior to water treatment.	Potentially applicable
DISPOSAL/DISCHARGE/REUSE	Onsite Discharge	Onsite Ponds/Evaporation Ponds	Treated groundwater for discharge to onsite evaporation pond.	Potentially applicable
	Offsite Discharge	POTW	Treated groundwater discharged to local POTW.	Not applicable
		Offsite TSDF	Collected onsite liquids transported and disposed of at a permitted TSDF which could include incineration or other treatment technology specific to the waste.	Potentially applicable
		Offsite Wetlands/Stream/River	Treated clean groundwater discharged through wetlands to offsite drainage under the site under site-specific NPDES permit.	Potentially applicable

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
VAPOR TREATMENT				
EX-SITU VAPOR TREATMENT	Vapor Treatment Systems	Thermal oxidation	Treatment of extracted vapors containing hydrocarbons or VOCs by thermal destruction in oxidizers that burn fuels such as natural gas or propane. Includes catalytic oxidizers and flameless oxidizers.	Potentially applicable
		Adsorption	Treatment of extracted vapors by adsorption of hydrocarbons or VOCs in media such as vapor phase carbon or polymeric resins. The adsorption media is either taken offsite for recycling/reuse or regenerated onsite.	Potentially applicable
		Refrigeration/Condensation	Treatment of extracted vapors containing VOCs by cooling and compressing to condense and remove VOCs. Condensed contaminants are removed as liquids and either taken offsite for treatment/disposal or treated onsite.	Potentially applicable
		Scrubber	Treatment of extracted vapors containing acids (e.g. HCl from catalytic oxidizer) by an acid scrubber where the vapors are contacted with a spray of alkaline (e.g. NaOH) water to dissolve and neutralize the acid.	Potentially applicable
SURFACE WATER/STORM WATER				
STORMWATER CONTROLS	Best Management Practices (BMPs)	Stormwater Management	Best practices for stormwater management.	Potentially applicable
	Surface Drains	Drainage/diversion structures/swales	Constructing new /improving existing drainage / diversion structures / swales.	Potentially applicable
	Erosion Controls	Geomats	Water permeable polymer or other synthetic material used to fix/stabilize soil elements, grass and small roots to control wind and water erosion, especially in sloped areas.	Potentially applicable
	Retention Basins	Retention Basins	Constructing new /improving existing rainwater collection structures or ponds with HDPE liner to hold stormwater for short periods of time before offsite discharge.	Potentially applicable
TREATMENT	Biological Treatment	Constructed Wetlands	Using constructed or artificial wetlands to treat surface water with low levels of metals, VOCs and other organics using natural geochemical and biological processes inherent in a functioning wetland ecosystem. Wetlands would primarily serve to filter and degrade contaminants. Constructed wetlands would typically include organic rich soils, plants, algae, microbes, fungi, etc.	Potentially applicable
DISPOSAL/DISCHARGE/REUSE	Onsite Discharge	Onsite Ponds/Evaporation Ponds	Collected surface water discharged to onsite ponds.	Potentially applicable
	Offsite Discharge	POTW	Collected surface water discharged to local POTW.	Not applicable

TABLE 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENTS
		Offsite Wetlands/Stream/River	Collected clean surface water discharged through wetlands to offsite drainage under the site.	Potentially applicable

NOTES

1. This table presents the initial screening of a wide range of remedial technologies for soil/sediment, surface water, groundwater, extracted groundwater and vapor treatment.
2. Rows with the crosshatching denote those process options that are not retained after initial screening.

TABLE 9-2
SCREENING OF TECHNOLOGIES – SOIL, SOIL VAPOR AND SEDIMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

TECHNOLOGY TYPE/ PROCESS OPTION	DESCRIPTION	CONTAMINANT SCENARIO	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
SOIL						
INSTITUTIONAL CONTROLS						
Institutional Controls - Restrictive Covenants (deed restrictions) - Zoning Restrictions - Informational Tools - Long Term Stewardship Tools	Institutional controls are legal and administrative controls applied to properties to minimize the potential for human exposure to residual contamination and protect the integrity of the remedy (e.g. caps or treatment systems). ICs work by controlling land or resource use and by providing information that helps modify use of the property. Restrictive covenants (deed restrictions) are a commonly used form of IC that runs with the land over the long term even if property ownership changes.	VOCs, SVOCs and other organics, and Metals in soil	Good Effective for preventing exposure to impacted groundwater because deed restrictions run with the land even if ownership changes.	Good Technically implementable provided specific legal requirements and authority can be met	Low	Retained Applicable in combination with other remedial technologies.
Soil Vapor Monitoring	Monitoring of existing soil vapor probes as indicated in the current soil vapor monitoring program is expected to continue as part of long term monitoring as outlined in the "Sampling Plan for Soil Gas Monitoring", April 6, 2009 (CSC 2009).	VOCs in soil gas	Good Effective for the purpose of monitoring as an indicator of soil vapor risks or concerns or to make the case that soil vapor monitoring is not required.	Good As implemented currently	Low	Retained
CONTAINMENT						
Simple Cap - Compacted soil cover - Vegetative layer - Eco-cap	Creates a barrier using compacted soil to prevent direct contact with impacted soil and reduce leaching to groundwater. Often topped with a vegetative layer that also serves as an erosion control layer. Can also include asphalt or concrete caps to achieve same objective.	Metals in soil VOCs, SVOCs and other organics in soil	Moderate to Good Effective for controlling direct contact with contaminants. Can reduce rainwater infiltration and soluble contaminant migration to groundwater.	Good Readily implementable	Moderate	Retained For potential use with less impacted soils for metals, VOCs or other organic contaminants.
Complex Caps Multilayer Barriers (RCRA or RCRA-equivalent cap) - RCRA Subtitle C cap - Clay monocover (meet permeability specifications) - Evapotranspiration (ET) cap - RCRA Subtitle D cap	Complex multilayer RCRA or RCRA-equivalent caps are rigorously engineered for low permeability with thick layers of clay and/or geomembrane liners for low permeability to minimize contact and leaching. Includes vapor extraction within layers to remove any infiltrating vapors, if gas or vapor control is needed. Also, includes an infiltration layer with gravel or permeable material, and a vegetative layer on top that also serves as an erosion control layer. ET caps are designed to store and then lose moisture by transpiration and evaporation.	Metals in soil VOCs, SVOCs and other organics in soil	Good Effective for controlling direct contact, preventing infiltration and leaching of soluble metal contaminants to groundwater.	Good Technology is implementable and has been implemented in the Capped Landfills Area. Some challenges in steeply sloped areas.	High	Retained A complex multilayer cap (RCRA prescriptive cap) would be appropriate for those areas with widely distributed non-VOC contaminants and VOC and NAPL-impacted soils. Gas-tight caps are not likely necessary based on limited gas formation in the landfills further assessment would be conducted during design. RCRA-equivalent caps (e.g. clay monocover) or ET monocover caps maybe appropriate for those areas with lower contaminant levels but have more steep slopes because the geomembrane caps could be prone to slip failure on steep slopes.

TABLE 9-2
SCREENING OF TECHNOLOGIES – SOIL, SOIL VAPOR AND SEDIMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

TECHNOLOGY TYPE/ PROCESS OPTION	DESCRIPTION	CONTAMINANT SCENARIO	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Pond liners - Stormwater basin liner - Evaporation pond liner	Similar to a cap, pond lining technology is intended to prevent infiltration of pond liquids into the subsurface. Typically a single layer barrier is used for a stormwater retention basin while an evaporation pond with groundwater (treated for VOCs) will use a double layer HDPE barrier and could include a leachate collection system and leak detection in the vadose zone.	Stormwater Groundwater (treated for VOCs)	Good Effective at controlling infiltration of liquids into the subsurface.	Good Technology has been implemented at numerous landfills and other facilities with ponds.	Moderate to High	Retained For potential use with stormwater retention basins and evaporation ponds proposed in the remedial alternatives.
ACTIVE IN-SITU TREATMENT						
Soil Vapor Extraction	Extract soil vapor from vapor extraction wells with a vacuum blower and treat in aboveground system with activated carbon or thermal oxidizer. This technology is usually implemented to remove VOCs in shallow or deep soils and is effective in moderate to permeable soils.	VOCs, SVOCs and other Organics in soil	Poor Vapor extraction flow in this fractured bedrock lithology will be predominantly in the fractures and will not effectively treat the contaminants in the soil matrix.[6]	Moderate Uneven vapor flows depending on vapor wells intersecting fractures, low reliability with this technology in this lithology.	Moderate	Not retained Due to the poor effectiveness in the fractured claystone bedrock lithology where vapor extraction flows will be predominantly in the fractures and this technology will not effectively treat the contaminants in the soil matrix. See Note [6] below for further discussion on conductivity and effectiveness for in-situ technologies in fractured bedrock.
In-situ Thermal Desorption (ISTD) -Thermal Wells -Thermal Blankets	A form of thermally enhanced SVE where soil is heated using thermal blankets / thermal wells that use resistive heating elements with associated vapor extraction to remove volatilized contaminants. Soil is heated by thermal conduction, and no current flows through soil.	VOCs in soil	Moderate Due to the low effectiveness in fractured bedrock lithology where vapor flow will be predominantly in the fractures and will not uniformly treat the contaminants in the soil matrix.[6]	Moderate Uneven vapor flows depending on vapor wells intersecting fractures, low reliability with this technology in this lithology.	Very High	Not retained Not retained for a VOCs solely in the vadose zone due to the low cost effectiveness in the fractured claystone bedrock lithology. However, this technology is retained for the VOCs and NAPLs in the saturated zone in Table 9-3. See Note [6] below for further discussion on conductivity and effectiveness for in-situ technologies.
		SVOCs and other Organics in soil	Moderate Due to the low effectiveness in fractured bedrock lithology where vapor flow will be predominantly in the fractures and will not uniformly treat the contaminants in the soil matrix.[6]	Moderate Uneven vapor flows depending on vapor wells intersecting fractures, low reliability with this technology in this lithology. Will need very closely spaced wells, typically 8 foot spacing.	Very High	Retained For evaluation of remedial alternatives specifically for RISBON-59 area (FS Area 3, Hotspot Location 10) that is impacted with PAHs and other organics.
Electric Resistance Heating Thermally enhanced SVE	Electric resistance heating involves heating soil (about 200°F) by passing a current directly through soil using electrodes placed in soil. The vapor and steam from the heated zone are extracted by SVE. This technology is typically used in the saturated zone and not often in the unsaturated zone.	VOCs, SVOCs and other organics in soil	Poor to Moderate Due to the poor effectiveness in fractured bedrock lithology [6] and uneven heating in the vadose zone because this technology requires moisture to conduct electricity.	Moderate Uneven vapor flows depending on vapor wells intersecting fractures. Challenges with implementation in the vadose zone.	Very High	Not retained Due to the poor cost effectiveness in the fractured claystone bedrock lithology and due to challenges with implementation in the vadose zone. ISTD is retained as a representative thermal technology that is better suited for the vadose zone contamination and lithology at this site. See Note [6] below for further discussion on conductivity and effectiveness for in-situ technologies.
EX-SITU TREATMENT						

TABLE 9-2
SCREENING OF TECHNOLOGIES – SOIL, SOIL VAPOR AND SEDIMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

TECHNOLOGY TYPE/ PROCESS OPTION	DESCRIPTION	CONTAMINANT SCENARIO	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Excavation	Excavation of contaminated soils for either treatment or disposal in onsite landfill; replace with clean backfill.	VOCs, SVOCs and other organics, and Metals in shallow soil	Good Effectiveness is good because the impacted soils can be removed to protect direct contact exposures to humans or eco-receptors.	Good No technical challenges are anticipated with excavation. Impacted soils can be placed in on onsite landfill.	Moderate	Retained Because it is easily implemented especially for shallow soil with available capacity in the PCB landfill for disposal.
		VOCs, SVOCs and other organics in deep soil	Moderate Depth limits access to contaminated soils. Significant health risks from potential toxic emissions during excavation to onsite workers.	Moderate Some technical challenges and risks associated with deep excavations and the need for shoring.	High	Retained Because of the evaluation of excavation of source areas such as the removal of trenches in the Burial Trench Area, excavation of RISBON-59 and Ponds A/B. VOCs and other organics in deeper saturated zone soil not considered for excavation because of technical challenges and poor cost effectiveness with offsite disposal.
Thermal desorption	Soil is heated to thermally desorb contaminants, which are then treated in the vapor phase using thermal oxidation. Treated soil can either be backfilled or disposed/recycled offsite.	VOCs, SVOCs and other organics in shallow soil	Moderate Effective for semivolatiles such as PAHs, pesticides and PCBs.	Moderate Some technical challenges for high boiling point chemicals and bedrock soils. Also, administrative challenges with potential for forming dioxins on combustion.	High	Not retained because (1) this option is not cost effective at $200/ton compared to other options such as offsite disposal ($40 to 80/ton) or placing in existing PCB landfill ($6/cy); (2) there is no specific need for treated soil for onsite reuse. Only way this technology would be required would be if an excavation needs to be done (as opposed to capping) and the soil volume is larger than PCB Landfill capacity and the offsite landfill option is deemed not viable or not preferable.
			Moderate to Good VOCs are readily thermally desorbed.	Moderate Some technical challenges can be expected with treatment of bedrock soils that may tend to be present in clumps that would need pretreatment.	High	
Vapor Extraction in Soil Piles	Excavated soils are placed in covered soil piles with interbedded slotted pipe. A blower is connected to the slotted pipes and vapors are extracted which are then treated in the vapor phase.	VOCs, SVOCs and other organics in soil	Poor to Moderate VOCs are readily removed by vapor extraction in alluvial soils but effectiveness is limited for weathered bedrock which is the significant portion of the impacted soil volume at the site. Also, SVOCs and other organics are commingled in soil for which vapor extraction is not effective.	Moderate Technical challenges with implementation due to the weathered bedrock formation soils.	Moderate to High	Not retained Because majority of the impacted soils at the site are in the weathered bedrock formation, these soils do not have good effectiveness for SVE in soil piles because of the nonuniform permeability, the clumpiness of the excavated material and the commingled SVOCs and other organics.
Onsite Stabilization -Pozzolanic stabilization - Cement stabilization -Polysilicate fixation -Asphaltic recycling	Contaminated soils are mixed with inorganic binders such as cement or pozzolans to form stabilized soil chunks to concrete blocks, which are then landfilled. For organics, soils are mixed with asphalt emulsion to form a useable asphalt product for paving or other use.	Metals in soil	Good Metals are more readily amenable to stabilization e.g. cement stabilization.	Good No technical challenges. Widely used technology.	High	Retained Cement stabilization is retained only for metals. PCBs are not readily amenable to stabilization but has stabilization has been used when contaminant levels are low (non-TSCA levels <50 mg/kg).

TABLE 9-2
SCREENING OF TECHNOLOGIES – SOIL, SOIL VAPOR AND SEDIMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

TECHNOLOGY TYPE/ PROCESS OPTION	DESCRIPTION	CONTAMINANT SCENARIO	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
		VOCs, SVOCs and other organics in soil	Moderate Has been effective for low levels of organic-impacted soils. Not effective for elevated VOC soils.	Moderate Technical challenges with potential leaching from VOCs.	High	Not retained PCBs are not readily amenable to stabilization but has stabilization has been used when contaminant levels are low (non-TSCA levels <50 mg/kg).
Onsite Landfarming/ -Bioremediation -Biopiles	Soil is laid in shallow piles and treated by supplying air, moisture and nutrients needed for bioremediation of contaminants.	Metals in shallow soil	Poor to Moderate Metals, pesticides and PCBs are difficult to biodegrade.	Poor Technical challenges with biodegradation due to recalcitrant contaminants and bedrock soils that would be clumpy.	Moderate to High	Not retained Due to poor technical implementability and effectiveness challenges.
		VOCs, SVOCs and other organics in shallow soil	Moderate Limited effectiveness for chlorinated VOCs which is the predominant VOC contaminant and because of the clayey soils are difficult to treat.	Poor Technical challenges with biodegradation of chlorinated hydrocarbons and controlling volatilization.	Moderate to High	Not retained Since chlorinated VOCs are a more significant contaminant at this site compared to petroleum VOCs.
DISPOSAL/REUSE						
Offsite Treatment/Disposal - Landfill Disposal - Thermal Desorption - Landfarming/Bioremediation	Soil will be loaded in sealed containers or tarped trucks for transport offsite for subsequent treatment or disposal. Offsite treatment/disposal includes thermal desorption, landfarming, and landfill disposal.	Metals, VOCs and other Organics in surface and shallow soil	Good If contaminated soil is acceptable to vendor facility.	Good Transportation and disposal facilities are readily available.	High	Retained Because it is effective and implementable though it is expected to be higher in cost than disposal onsite at the PCB Landfill. PCB Landfill capacity to receive onsite wastes is limited to about 70,000 cy.
Onsite landfill	Excavated soil will be transported to an onsite landfill (e.g. PCB landfill) that has available storage capacity.	Metals, VOCs and other Organics	Good Available capacity in the PCB landfill can accept most onsite wastes.	Good No significant technical challenges.	Low	Retained Because it is the most cost-effective option while there is capacity in the PCB landfill. However, PCB Landfill capacity to receive onsite wastes is limited to about 70,000 cy.
SEDIMENTS						
Stormwater Controls - BMPs - Surface drains - Detention basin - Swales	Involves installing drainage improvements, swales, BMPs to improve stormwater collection through drains and swales and sediment settling and filtration in detention basins.	Metals, VOCs, SVOCs and other organics in surface water, potential sediment/contaminant migration	Moderate to Good Effectiveness can be limited by site specific factors including alignment and location of drainage.	Moderate Site-specific challenges can be anticipated.	Moderate to High	Retained Because these controls are important to divert rainwater through drains/swales to minimize contact with impacted soils and contaminant transport via sediments.

TABLE 9-2
SCREENING OF TECHNOLOGIES – SOIL, SOIL VAPOR AND SEDIMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

TECHNOLOGY TYPE/ PROCESS OPTION	DESCRIPTION	CONTAMINANT SCENARIO	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Erosion Controls - Geomats - Geonets	Involves installing erosion controls such as geomats from sloped areas to control soil loss during wind and water erosion especially in sloped areas.	Soil erosion and potential contaminant migration Metals, SVOCs and other organics in surface soil	Moderate to Good Effectiveness can be limited by building specific factors including pressure variations across the building.	Moderate Building-specific challenges can be anticipated.	Moderate	Retained Because these controls are important to avoid erosion of impacted soils or erosion of clay caps to expose impacted soils.

NOTES

1. Surface soil is 0-1 ft bgs, shallow soil is 0-15 ft bgs, deep soil is 15 ft bgs to water table.
2. Definitions of Criteria :
   -Effectiveness is ability of the remedial technology to achieve remedial action objectives;
   -Implementability is a measure of the technical and administrative feasibility of constructing, operating and maintaining a remedial alternative; and,
   -Cost refers to a relative cost compared with other technologies in same technology type. Costs will be refined later in the FS process.
3. Table uses a five-point rating scheme: Good, Moderate to Good, Moderate, Poor to Moderate, Poor for Effectiveness and Implementability.
   For Cost the table uses Low, Low to moderate, Moderate, Moderate to High, High.
4. Retained technologies are identified as shaded rows.
5. Contaminant scenario is divided into two groups: VOCs, SVOCs and other organics; and, Metals in soil.
6. Section 4 of the RI states that the geometric mean of the hydraulic conductivity of UHSU weathered claystone is approximately $1x10^{-5}$ cm/s and that fractures control hydraulic conductivity in the UHSU. Important points to note in evaluating in-situ technologies in this fractured bedrock site lithology a) a fractured bedrock with a $1x10^{-5}$ cm/s conductivity is significantly worse with respect to in-situ remediation effectiveness than an unconsolidated formation with the same conductivity because with a fractured bedrock a majority of the flow (depending on in-situ remediation approach it could be vapor extraction flow or reagent injection flow, etc.) is going to be through the fractures while in an unconsolidated formation this will be more uniformly distributed; b) a majority of the porosity in the UHSU is in the matrix (>40%) while the porosity of the fractures is <5% which implies that a majority of the contaminants are likely in the matrix where the available porosity is. Hence, addressing the fracture porosity with the in-situ remediation approach will not address a significant portion of the contamination in the matrix.

TABLE 9-3
SCREENING OF TECHNOLOGIES – GROUNDWATER, NAPL AND STORMWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

TECHNOLOGY TYPE/ PROCESS OPTION	DESCRIPTION	CONTAMINANT SCENARIO	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
GROUNDWATER AND NAPL						
INSTITUTIONAL CONTROLS						
Institutional Controls - Groundwater Use Restrictions - Well Restrictions - Restrictive Covenants (deed restrictions) - Zoning Restrictions - Informational Tools - Long Term Stewardship Tools	Institutional controls are legal and administrative controls applied to properties to minimize the potential for human exposure to residual contamination and protect the integrity of the remedy. ICs work by controlling land or resource use and by providing information that helps modify use of the property. Restrictive covenants (deed restrictions) are a commonly used form of IC that runs with the land over the long term even if property ownership changes.	Dissolved contaminants in groundwater NAPL	Good Effective for preventing exposure to impacted groundwater because deed restrictions run with the land even if ownership changes.	Good Technically implementable provided specific legal requirements and authority can be met.	Low	Retained Applicable in combination with other technologies.
Groundwater Monitoring - UHSU - LHSU	Long term monitoring of the groundwater well network to assess plume stability and NAPL and contaminant concentration trends over time. This includes monitoring of UHSU and LHSU saturated zones.	Dissolved contaminants in groundwater NAPL	Good Effective for monitoring contaminant concentration over time	Good Monitoring well network is already established.	Low to Moderate	Retained Applicable in combination with other technologies for use with UHSU and LHSU groundwater zones.
CONTAINMENT						
Slurry Walls Impermeable Barriers	Install impermeable or low permeability barriers such as a slurry wall on the downgradient side of the NAPL to a depth below the NAPL in the saturated zone. Materials for barriers include cement slurry, soil bentonite, clay, etc. Long term monitoring would be required.	Dissolved contaminants in groundwater NAPL	Good Effective at preventing groundwater contaminant migration and as a barrier that enhances groundwater extraction/treatment systems. Does not reduce toxicity or mass but reduces potential for migration and exposure.	Moderate to Good Has been implemented successfully at the site. Used in concert with groundwater extraction, this technology is implementable within shallow and accessible areas (e.g. P/S landfill clay barrier).	Moderate to High	Retained Because it is an effective technology at preventing groundwater migration in the Upper HSU. Applicable for groundwater in all three subareas: Area 5 North, 5 South and 5 West. Currently this technology is operating effectively at the P/S Landfill clay barrier and the PCT clay barrier. This technology is used in concert with hydraulic extraction at the PCT trenches to prevent offsite migration of impacted groundwater. Not applicable in the Lower HSU because implementing a slurry wall or other barrier would not be feasible in the Lower HSU, which is over 1,000 feet thick. However, the very low permeability (hydraulic conductivity of $1x10^{-6}$ cm/s) minimizes potential migration is a natural barrier or control.
Hydraulic Barrier or Hydraulic Control	Extraction and injection wells or trenches are used to create a hydraulic barrier by the formation of a cone of depression to restrict groundwater flow and contaminant migration. Or extraction alone to provide hydraulic control and prevent offsite migration. Treatment of groundwater may be required depending on contaminants present and end disposal option. Long term monitoring would be required.	Dissolved contaminants in groundwater NAPL	Moderate to Good Effective in the weathered, fractured Upper HSU lithology using trenches for extraction. Significant energy usage and greenhouse gas (GHG) emissions over the long term.	Moderate to Good Technically implementable for Upper HSU only. Fractures cause preferential pathways and uneven capture.	High	Retained This is similar to current extraction based hydraulic control at the PCT trenches that prevent impacted groundwater from being transported offsite. However, this will require active groundwater pumping in perpetuity. Applicable for groundwater in all three subareas: Area 5 North, 5 South and 5 West. Significant long term GHG impacts on environment. GHG impacts may be less significant if the overall pumping rates are significantly decreased due to anticipated capping remedies.

TABLE 9-3
SCREENING OF TECHNOLOGIES – GROUNDWATER, NAPL AND STORMWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Phytoremediation	Use of plants and trees as a containment approach to extract contaminated groundwater and help with hydraulic control to prevent migration of contaminated groundwater. Phytoremediation can also be used to remediate or stabilize contaminants in vadose zone soil, sediments and surface water.	Dissolved contaminants in groundwater	Moderate Effectiveness limited by depth of water table, elevated concentrations of contaminants and weathered claystone soil type that will limit the types of vegetation that can grow.	Moderate Challenges anticipated with water table that is deep compared to typical plant root zones and weathered claystone soil type that limits the types of vegetation that can grow.	Low to Moderate	Retained Potential applications in limited areas of the site with a shallow water table or would need a groundwater extraction to supply water to plants. Applicable in portions of Area 5 South and Area 5 West where the water table is shallow and organic and inorganic contaminant concentrations are low and less impacting to plants. However, TDS concentrations are high and can pose a challenge to plant growth. Also, water table elevations are expected to be lowered in the future due to the anticipated capping remedies. Not applicable in Lower HSU because of the greater depth to water unless groundwater is pumped through extraction wells.
PASSIVE IN-SITU TREATMENT						
Monitored Natural Attenuation Intrinsic biodegradation	Reduction of dissolved concentrations through naturally occurring processes such as dilution, volatilization, biodegradation, or adsorption. Long term groundwater monitoring would be required.	Dissolved contaminants in groundwater NAPL	Low to Moderate Chlorinated and petroleum VOCs are amenable to biodegradation, but mass reduction in the source area is very slow. Reductive dechlorination of chlorinated ethenes has potential to produce toxic byproducts. Effectiveness evaluated through monitoring.	Moderate to Good Adequate network of monitoring wells are already in place.	Low	Retained Though this technology is rated low for effectiveness/mass removal, it is retained because it is a cost-effective approach that can reduce dissolved contaminant mass over a long period of time. Applicable primarily to Area 5 South, Area 5 West south of the PSCT where natural attenuation plays a significant role in contaminant destruction. Also applicable to the Area 5 North in the Lower HSU.
Permeable Reactive Barriers (PRBs) Reactive Walls (ZVI) Funnel and Gate Biobarriers (Carbon source) Injection well barrier	Installation of PRBs (in-situ reactive walls) in the subsurface across the direction of NAPL/groundwater flow to passively treat contamination typically using deep trenches. Funnel and gate is a type of construction where impermeable slurry walls are used to direct groundwater flow through a narrow region called a funnel that is filled with a reactive medium (e.g. Zero valent Fe). For a mixed chlorinated and petroleum VOC plume a combination of materials have been used in the barrier (ZVI, carbon source, activated carbon, microbes, etc.) which involve chemical reduction and anaerobic biodegradation. PRBs can also be installed using a series of closely-spaced direct push injection points or closely spaced wells.	Dissolved contaminants in groundwater NAPL	Moderate to Good Effective for reduction of dissolved VOCs and acting as a barrier. ZVI alone is not effective for petroleum hydrocarbons. A combination of barrier materials would be required to address a mixed chlorinated and petroleum VOC plume. Not proven effective for NAPL mass removal.	Moderate to Good Typically implementable as a reactive wall up to depths of less than 50 feet. Locally contamination has been found deeper up to 140 feet bgs and trenching cannot be implemented at those depths.	High	Retained PRBs have been successfully used as a containment remedial option for depths in the range of 40-50 ft bgs. ZVI and carbon have been useful reactive media for reductive or biological degradation of chlorinated solvents. Applicable to Area 5 South where low levels of chlorinated solvents and metals are the dominant contaminants. Applications in Area 5 North would be very challenging with very high VOC concentrations and in close proximity to NAPL. Area 5 West with a mix of low levels of metals is potentially applicable but challenges can be expected with a mix of different metals with different redox chemistries. PRBs using injection wells are not retained for this site due to the challenges with injection in the weathered claystone formation.

TABLE 9-3
SCREENING OF TECHNOLOGIES – GROUNDWATER, NAPL AND STORMWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ACTIVE IN-SITU TREATMENT						
Air Sparging	Involves injection of compressed air through injection wells to strip and biodegrade hydrocarbons with volatiles captured in vadose zone by soil vapor extraction. Sparging wells would need to be screened in the top 30 to 40 feet of the groundwater table zone.	Dissolved VOCs in groundwater NAPL	Poor to Moderate Not effective in low permeability fractured or weathered bedrock conditions, especially because it has to be applied over a large thickness (>30 feet) of saturated zone. Air will flow in preferential pathways in fractures and remediation will be highly nonuniform.[6, 7]	Moderate Challenges with air injection in low permeability, heterogeneous weathered/fractured bedrock conditions. Would need very closely spaced points.	High	Not retained Because of poor effectiveness and implementation difficulties in this low permeability heterogeneous subsurface where the preferential pathways of injected air flow and low air flow allowed will make it ineffective. See Note [6,7] below.
In-situ Thermal Desorption (ISTD)	ISTD is equivalent to a thermally enhanced SVE. Involves heating deep soil using thermal wells that use resistive heating elements with associated vapor extraction to remove volatilized contaminants. Soil is heated by thermal conduction, and no current flows through soil.	Dissolved contaminants in groundwater NAPL	Moderate Due to challenges with uniformly capturing heated vapors and nonuniform heating in this fractured bedrock lithology. [6,7] Significant energy consumption and GHG emissions.	Moderate High density of vapor wells would be required to capture vapors. Low permeability conditions could be challenging for vapor flow. Available through only one vendor.	Very High	Retained This technology is considered better than the other thermal technologies for this site and is retained as an example of a thermal technology for alternative screening evaluation. Applicable to NAPL and VOC impacted areas in Area 5 North. VOC concentrations in Area 5 South are low for this technology to be cost effective. Effectiveness for DNAPL in the LHSU is highly uncertain with the very low permeability and challenges with effective extraction of heated vapors. Also, exact extent of DNAPL is not known and hence not applicable for LHSU.
Electric Resistance Heating (ERH)	Electric resistance heating involves heating soil (about 200°F) by passing a current directly through soil using electrodes placed in soil. In the saturated zone, sufficient electric power is applied to boil the water and volatilize the NAPL. The vapor and steam from the heated zone are extracted by vacuum extraction and treated in aboveground systems.	Dissolved contaminants in groundwater NAPL	Poor to Moderate Due to challenges with uniformly capturing heated vapors and nonuniform heating in this low permeability weathered or fractured bedrock lithology. [6,7] Significant energy consumption and GHG emissions.	Moderate Technically implementable in Upper HSU only. High density of vapor wells would be required to capture vapors due to low permeability weathered/fractured bedrock.	Very High	Not retained Because of implementation and effectiveness challenges and very high cost compared to other technologies. Also, significant environmental impacts with high GHG emissions and associated impacts compared to other greener in-situ remediation options. See Note [6,7] below.
In-situ Chemical Oxidation (ISCO) - $KMnO_4$ (Permanganate) - Ozone - H_2O_2 + Fe (Fentons reagent) - Peroxone (H_2O_2 + O_3) - Persulfate - RegenOx™ (Percarbonate+H_2O_2)	Strongly oxidizing chemicals (such as Ozone, H_2O_2, $KMnO_4$) are injected into the subsurface to oxidize the NAPL in-situ. The added oxidant also enhances biodegradation of residual contamination in the long term. Permanganate is the most successfully used oxidant especially for chlorinated solvent contamination including DNAPL areas.	Dissolved contaminants in groundwater NAPL	Poor to Moderate Due to low permeability weathered or fractured bedrock lithology, injection technologies would face significant challenges in contacting the contaminants in the matrix. Most injectate would flow in fractures.[6,7]	Moderate Challenges with injection into low permeability, heterogeneous, weathered or fractured bedrock. Injection attempted with hydraulic fracturing would be nonuniform.	High	Not retained Because injection technologies have significant limitations with effectiveness and implementability in this lithology. Typically chemical oxidation technologies are not used with passive barrier type approaches because oxidants are fast reacting and are consumed quickly. See Note [6,7] below.

TABLE 9-3
SCREENING OF TECHNOLOGIES – GROUNDWATER, NAPL AND STORMWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Enhanced Anaerobic Bioremediation/ Bioaugmentation - Emulsified vegetable oil (EVO) - Emulsified Oil Substrate (EOS) - Molasses - EHC, DARAMEND (Adventus) - HRC™ (Regenesis) - Microbes (dehalococcoides,KB-1) - Cometabolism (methane sparging)	Direct injection of substrates/nutrients/microbes or placement in reactive barriers to enhance in-situ bioremediation (bioaugmentation) of VOCs (often used for chlorinated VOCs). Also, can be implemented as groundwater extraction followed by aboveground substrate/nutrient injection and subsequent re-injection into the saturated zone.	Dissolved contaminants in groundwater NAPL	Moderate Effective only for reactive barriers or funnel and gate type applications. Not for direct injection.	Moderate Only for reactive barrier or funnel and gate type application and not for injection.	High	Not retained Has potential applicability to chlorinated solvent remediation in a funnel and gate or reactive barrier application where the gate is an anaerobic biobarrier. However, an ISCR barrier discussed below is likely to be better suited for this application because the biobarrier would need more frequent replacement while ZVI would last longer.
In-situ Chemical Reduction (ISCR) ISCR+in-situ bioremediation - Zero Valent Iron - EHC (Adventus, Carbon + ZVI)	Direct injection or placement of ZVI in reactive barriers or funnel and gate applications to reduce chlorinated solvents or metals without groundwater extraction. Also, a combination of ISCR with bioremediation can be implemented when ZVI is combined with a carbon source.	Dissolved contaminants in groundwater NAPL	Moderate Effective only for reactive barriers or funnel and gate type applications. Not for direct injection.	Moderate Technical challenges with injection into fractured bedrock formation.	High	Retained for use as a gate material for dissolved groundwater and for direct injection for NAPL. Has potential applicability to chlorinated solvent remediation mostly in a funnel and gate or reactive barrier application where the gate uses ZVI or ZVI+carbon by ISCR. Applicable primarily for the UHSU because that would be the focus of the PRBs. Not applicable for the LHSU because a PRB barrier would not be effective where the LHSU is over 1,000 feet thick.
EXTRACTION WELLS						
Vertical Wells	Series of wells to extract impacted groundwater as part of hydraulic control or extract NAPL as source control to limit contaminant migration. They can be used to remove LNAPL and DNAPL mass from the subsurface, hydraulically control LNAPL migration, and partially control DNAPL migration.	Dissolved contaminants in groundwater NAPL	Moderate Limited effectiveness due to the low permeability weathered or fractured bedrock lithology. The lithology significantly reduces the potential extraction flow rate and capture zone. This option is rated higher at moderate because vertical wells used with large diameter boreholes or inside trench wells would be better than vertical wells in conventional 8 or 10-inch boreholes.	Moderate to Good Installation of wells is good for implementability but a large number of closely-spaced wells will be required and hence rated lower than good.	Moderate	Retained for use to extract groundwater and also to selectively extract NAPL. Hydraulic control of DNAPL is only partially effective because DNAPL migration is density driven and only partially influenced by hydraulic gradients. Removal of the mobile DNAPL source is necessary to control DNAPL migration.
Trench Wells	Deep trenches that extend below water table to extract impacted groundwater as part of hydraulic control or source control to ensure DNAPL or dissolved contaminant migration is limited. They can be used to remove LNAPL and DNAPL mass from the subsurface, hydraulically control LNAPL migration, and partially control DNAPL migration.	Dissolved contaminants in groundwater NAPL	Moderate to Good Better effectiveness based on intercepting a larger cross section of groundwater flow.	Moderate Some technical challenges and safety risks with deep trenches with vertical sidewalls. However, these have been implemented at this site.	High	Retained for use to extract dissolved phase groundwater.

TABLE 9-3
SCREENING OF TECHNOLOGIES – GROUNDWATER, NAPL AND STORMWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Horizontal Wells	Horizontal wells are installed by directional drilling methods that extend several hundreds of feet long to access a greater portion of the saturated zone. They can be used to extract impacted groundwater as part of hydraulic control or extract NAPL as source control to ensure DNAPL or dissolved contaminant migration is limited. These wells have the potential to access contaminated groundwater under landfills without drilling through waste.	Dissolved contaminants in groundwater NAPL	Moderate Effectiveness is not as good as trench wells that can access a larger cross section of groundwater flow and achieve better extraction rates in this low permeability bedrock lithology. This option potentially allows access to groundwater under landfills without drilling through wastes as with vertical wells.	Poor to Moderate Significant technical challenges anticipated with horizontal drilling under landfills. Concerns with drilling into waste because the exact landfill bottom elevations are not known.	High	Retained for evaluation of alternative involving dewatering P/S Landfill to address source control objective. Hydraulic control of DNAPL is only partially effective because DNAPL migration is density driven and only partially influenced by hydraulic gradients. Removal of the mobile DNAPL source is necessary to control DNAPL migration.
EX-SITU TREATMENT						
Hydraulic Extraction Pump and Treat - UHSU wells - LHSU wells	Groundwater is extracted from subsurface wells creating a sufficient hydraulic gradient to mobilize NAPL or extraction dissolved VOCs. The recovered NAPL is destroyed or recycled, and groundwater is treated in aboveground equipment and discharged. The extraction technology is viable for the UHSU groundwater but is also considered to a limited extent with the LHSU groundwater where permeability and extraction rates are even lower.	Dissolved contaminants in groundwater NAPL	Moderate Effectiveness is limited by the weathered bedrock conditions and low aquifer conductivity in the UHSU. NAPL mass removal efficiency is low. Effectiveness is poorer with the LHSU groundwater because of the very low permeability claystone bedrock.	Moderate Limitations with this site lithology and low conductivity aquifer conditions in the UHSU. Limitations are more significant with LHSU groundwater.	Very High	Retained For NAPL in UHSU, mass reduction efficiency is low but VOC contaminant mass can be reduced in the dissolved phase. Cost depends on the density of wells and is generally very high because of the long term of operation. For dissolved plume in UHSU, this technology can serve as a control or containment feature and is used currently at the site. For LHSU, the permeability of the claystone bedrock is even lower and extraction rates are expected to be miniscule. Based on experience with purging monitoring wells, these wells recharge extremely slowly sometimes taking weeks to recharge one casing volume. [8]
Dual-Phase Extraction Multi-Phase Extraction	High vacuum (>20-inch Hg) is applied to subsurface wells to remove vapors, groundwater and NAPL which are treated aboveground. When the water table is deep, vacuum alone may not be able to extract significant liquids. Groundwater extraction pumps may be required for liquids extraction.	Dissolved contaminants in groundwater NAPL	Poor to Moderate Not effective in this site lithology due to the uneven fractures and inability to apply vacuum evenly [6,7]. Vacuum is not expected to significantly enhance liquids extraction in this formation compared to conventional hydraulic extraction.	Moderate Limitations in radius of influence in this fractured bedrock lithology needing very closely spaced wells.	High	Not retained Because of limited radius of influence and effectiveness in this low permeability, fractured bedrock subsurface. See Note [6,7].
NAPL Skimmers	Active or passive skimmers are placed in groundwater wells to remove any accumulating free product for collection in a tank and offsite disposal. Applicable for LNAPL and DNAPL.	NAPL	Moderate Effective for removal of free product that comes into a well. Does not apply a gradient to enhance NAPL entry into well.	Moderate to Good Implementable for LNAPL and DNAPL that enters well.	Low	Retained Because it can be effective for removal of DNAPL and LNAPL that comes into a well. Can be used for DNAPL-only skimming by optimizing the well construction for DNAPL entry into the well.

TABLE 9-3
SCREENING OF TECHNOLOGIES – GROUNDWATER, NAPL AND STORMWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Enhanced NAPL Recovery	Flushing with solvents (incl. water), surfactants and other chemicals to dissolve or alter the physical properties of the NAPL to make it more easily extractable. This could be potentially applicable for LNAPL or DNAPL. An example of an application for a DNAPL extraction is called "waterflood oil recovery" approach. Key to optimizing DNAPL extraction with this approach is maintaining maximum DNAPL saturation. Also, this technology has been utilized primarily in aquifers that have high conductivity (e.g. $1x10^{-3}$ cm/s) such as alluvial aquifers.	NAPL	Poor to Moderate Effectiveness is rated low because it is not expected to be effective in this site lithology that includes a low permeability ($1x10^{-5}$ cm/s) weathered claystone overlying even lower permeability ($1x10^{-6}$ cm/s) fractured claystone bedrock. Flow will be in preferential pathways along fractures [6,7]. Example application is a site with a high conductivity alluvial aquifer that is very different from this site.	Poor to Moderate Challenges with reinjection of extracted groundwater in this low permeability aquifer to enhance DNAPL pooling and recovery. Challenges with large diameter well installation or use of trench wells in the southern portion of the P/S Landfill where the largest amount of NAPL is believed to be present.	High	Not retained Because this technology works optimally in highly permeable alluvial (e.g. 10^{-3} cm/s) aquifers. The use of the waterflood approach would involve extraction of groundwater overlying DNAPL and reinjection to enhance DNAPL accumulation for recovery. The low permeability of the upper HSU would make reinjection difficult and further complicated by the high TDS and biofouling that would significantly impact and restrict the injection operations. See Note [6,7].
DISPOSAL/DISCHARGE/ REUSE						
Onsite Discharge	Onsite discharge of treated or extracted groundwater and uncapped areas stormwater to evaporation ponds. Evaporation is currently an actively used approach for disposal of treated groundwater. Evaporation rates at the site are high in the range of 44 to 48 inches per year. Evaporation pond sediments will accumulate inorganics deposited over a period of time and will need to be cleaned. Also, the CLRF and CTS species would need to be protected by using drift fences around the length of the pond.	Metals, TDS, suspended solids	Good Effective for disposal of treated groundwater that does not contain VOCs and organics but is elevated in TDS and inorganics. Pond sediments would need to be cleaned periodically. CLRF and CTS species will need to be protected.	Good Limited challenges with implementation and CLRF and CTS species would need to be protected and pond sediments periodically cleaned.	Low	Retained Because evaporation ponds are a cost effective means of addressing high TDS and inorganics in treated groundwater. However, onsite handling of treated water is limited by the available size of the onsite evaporation pond. If groundwater extraction rates are too high to be handled by the onsite evaporation pond, then more complex groundwater treatment should be considered to enable offsite discharge of treated groundwater.
Enhanced evaporation	Enhanced evaporation refers to an evaporation technology used in the mine industry to address water disposal. An example of this technology is Turbomist equipment (by Slimline Inc.) that sprays the water in a fine mist from jets with a blower.	Metals, TDS, suspended solids	Good Effective for disposal of treated groundwater that is high in TDS, suspended solids and metals.	Moderate to Good Would need to meet the substantive requirements of the SBCAPCD with regards to air emissions.	Moderate	Retained Because it is an effective technology that can reduce the volume of water especially in those wet years when extracted groundwater and stormwater volumes peak.
Offsite Discharge	Offsite discharge of extracted groundwater that is treated to remove contaminants such as VOCs, NAPL, metals and TDS with a complex treatment system (such as advanced oxidation, air stripping, LPGAC and reverse osmosis) to meet site-specific offsite NPDES discharge limits. The offsite discharge option is required when the extraction flow rates are high and the water cannot be handled in the onsite evaporation ponds.	VOCs, Other Organics, Metals	Moderate to Good Effective for discharge of treated groundwater though some effectiveness concerns exist with meeting stringent NPDES limits especially for inorganics.	Moderate Some technical challenges and reliability concerns with discharge quality and compliance with permit limits. Community concerns with offsite discharge of groundwater from the Site.	High	Retained Because it is the only option available if high groundwater extraction flow rates are considered that could not be handled in the onsite evaporation ponds.
	Offsite disposal of highly contaminated leachate liquids and NAPL to a permitted TSDF where liquids are treated by incineration or other processes	High levels of VOCs and Other organics, NAPLs	Good Effective in disposing of highly contaminated liquids but concerns exist with potential long term liabilities of offsite disposal and transportation risks.	Good Because it is currently implemented for Gallery Well liquids and NAPL disposal.	High	Retained Currently used approach for disposal of Gallery Well liquids and NAPL.

TABLE 9-3
SCREENING OF TECHNOLOGIES – GROUNDWATER, NAPL AND STORMWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

STORMWATER						
Stormwater Controls - BMPs - Surface drains - Detention basin - Swales - Erosion Controls	Involves installing drainage improvements, swales, BMPs to improve stormwater collection through drains and swales and sediment settling and filtration in detention basins.	Metals, VOCs, SVOCs and other organics in surface water, potential sediment/contaminant migration	Moderate to Good Effectiveness can be limited by site specific factors including alignment and location of drainage.	Moderate Site-specific challenges can be anticipated.	Moderate to High	Retained Because these controls are important to divert rainwater through drains/swales to minimize contact with impacted soils and ensure a clean runoff.
Onsite Discharge	Onsite discharge of uncapped areas stormwater to evaporation ponds. Evaporation is currently an actively used approach for disposal of treated groundwater as discussed earlier. Evaporation rates at the site are high in the range of 44 to 48 inches per year. Evaporation pond sediments will accumulate inorganics deposited over a period of time and will need to be cleaned.	Metals, TDS, suspended solids	Good Effective for disposal of treated groundwater that does not contain VOCs and organics but is elevated in TDS and inorganics. Pond sediments would need to be cleaned periodically. CRLFs and CTS species will need to be protected.	Good Limited challenges with implementation and CRLF and CTS species would need to be protected and pond sediments periodically cleaned.	Low	Retained Because evaporation ponds are a cost effective means of addressing inorganics or TDS in stormwater.
Constructed Wetlands	Using constructed or artificial wetlands to treat surface water with low levels (low µg/L concentrations) of metals, VOCs and other organics using natural geochemical and biological processes inherent in a functioning wetland ecosystem. Wetlands would primarily serve to filter and degrade contaminants. Constructed wetlands would typically include organic rich soils, plants, algae, microbes, fungi, etc.	Low levels of metals, VOCs, other organics, TDS, suspended solids	Good Effective for treating low levels of VOCs, other organics. Not typically known to be effective for high TDS.	Good The B Drainage Wetlands is an example of a constructed wetland though it primarily addresses stormwater flows from the site.	Moderate	Retained Because this technology is effective and there is already an example of the B Drainage Wetlands that has been operating effectively.
Enhanced evaporation	Enhanced evaporation refers to an evaporation technology used in the mine industry to address water disposal. An example of this technology is Turbomist (by Slimline Inc.) that sprays the water in a fine mist from jets with a blower.	Metals, TDS, suspended solids	Good Effective for disposal of treated groundwater that is high in TDS, suspended solids and metals.	Moderate to Good Would need to meet the substantive requirements of the SBCAPCD with regards to air emissions.	Moderate	Retained Because it is an effective technology that can reduce the volume of water especially in those wet years when extracted groundwater and stormwater volumes peak.
Offsite Discharge	Offsite discharge of surface water from capped or uncapped areas in accordance with the site's General NPDES permit	Low levels of Metals, Organics	Good Effective for discharge of clean capped stormwater and from uncapped areas with BMPs.	Good No challenges with capped flows but some uncertainty with uncapped areas stormwater quality and ability to discharge offsite under the General Permit.	Low	Retained Because it is the favored approach for discharge offsite of clean stormwater from capped and unimpacted areas.

TABLE 9-3
SCREENING OF TECHNOLOGIES – GROUNDWATER, NAPL AND STORMWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

NOTES

1. Definitions of Criteria :
   -Effectiveness is ability of the remedial technology to achieve the RAOs;
   -Implementability is a measure of the technical and administrative feasibility of constructing operating and maintaining a remedial alternative; and,
   -Cost refers to a relative cost compared with other technologies in same technology type. Costs will be refined later in the FS process.
2. Table uses a five-point rating scheme: Good, Moderate to Good, Moderate, Poor to Moderate, Poor.
   For Cost, the table uses a five-point rating scheme: Low, Low to moderate, Moderate, Moderate to High, High.
3. Technologies for NAPL are rated based on remedial objectives addressing source migration potential, risk to onsite workers, and containment.
4. Retained technologies in table are identified as shaded rows.
5. A Technical Impracticability (TI) waiver for chemical-specific groundwater ARARs as presented in the TI evaluation (Appendix A) is assumed to be granted by the USEPA.
6. Section 4 of the RI states that the geometric mean of the hydraulic conductivity of Upper HSU weathered claystone is approximately $1x10^{-5}$ cm/s while the Lower HSU mean is $1x10^{-6}$ cm/s and that fractures control hydraulic conductivity in both the Upper HSU and Lower HSU.
7. Important points to note in evaluating in-situ technologies in this fractured bedrock site lithology a) a fractured bedrock with a $1x10^{-5}$ cm/s conductivity is significantly worse with respect to in-situ remediation effectiveness from an unconsolidated formation with the same conductivity because with a fractured bedrock a majority of the flow (depending on in-situ remediation approach it could be vapor extraction flow or reagent injection flow, etc.) is going to be through the fractures while in an unconsolidated formation this will be more uniformly distributed; b) a majority of the porosity in the Upper HSU is in the matrix (>40%) while the porosity of the fractures is <5% which implies that a majority of the contaminants would likely be in the matrix where the available porosity is. Hence, addressing the fracture porosity with the in-situ remediation approach will not address a significant portion of the contamination in the matrix.
8. For the Lower HSU groundwater contamination, only groundwater monitoring and limited hydraulic extraction is retained for evaluation with remedial alternatives.

TABLE 9-4
SCREENING OF TECHNOLOGIES – EXTRACTED GROUNDWATER AND VAPOR TREATMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

TECHNOLOGY TYPE	DESCRIPTION	CONTAMINANT SCENARIO	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
EXTRACTED GROUNDWATER TREATMENT TECHNOLOGIES						
Liquid Phase Granular Activated Carbon (LPGAC) Powdered Activated Carbon (PAC)	Using LPGAC in a series of vessels to adsorb dissolved organic contamination in groundwater in aboveground treatment systems. Powdered Activated Carbon is used in wastewater treatment and has been used for some groundwater applications including landfill leachate treatment.	Dissolved VOCs and other organics in groundwater	Good Well proven for most VOCs at low to moderate concentrations except for a few such as vinyl chloride, methylene chloride.	Good Technically implementable.	Moderate to High	Retained Because it is an effective technology for VOCs in groundwater for low to moderate concentrations and as a polishing technology.
Synthetic resin - Macroporous Polymer Extraction (MPPE)	Using synthetic resins or polymeric beads to adsorb dissolved organic contamination in aboveground groundwater treatment systems	Dissolved VOCs and other organics in groundwater	Good MPPE has been more effective and is a viable option to be considered for aboveground treatment of high VOC and other organics in groundwater.	Moderate to Good Technically implementable but some uncertainty with reliability and limited number of vendors.	Very High	Retained for treating highly concentrated DNAPL groundwater stream Because it is an effective technology but limited number of full scale applications in groundwater remediation applications.
Air stripper	Using air stripper to strip VOCs from extracted groundwater that uses air injection from a blower. Air strippers can be in a packed bed or a parallel tray configuration.	Dissolved VOCs in groundwater	Good For those VOCs that have a high Henry's law constant and are easily stripped.	Good Technically implementable but challenges with high TDS in groundwater. May need acidification to solids in solution.	Moderate	Retained for use as part of a treatment train Because it is an effective technology for VOCs in groundwater. However, high dissolved solids in groundwater pose operational problems. Acidification prior to stripping can retain solids in solution.
Bioreactors	Bioreactors involved treatment of influent water with aerobic or anaerobic biodegradation including addition of microbes and nutrients and the use of media for growth of microbes. Fixed film or fluidized bed bioreactors are examples. Bio-PACT is an example of a combined bioreactor and activated carbon system.	Dissolved VOCs and other organics in groundwater	Good Has been used effectively in landfill leachate applications.	Good Has been used effectively in landfill leachate applications but some challenges with meeting air quality requirements of local agencies.	High	Retained for use as part of a treatment train. Because it has been used in landfill leachate treatment applications with VOCs and other organics.
Chemical oxidation/Advanced oxidation - Peroxide - Ozone - UV	Using injected oxidant chemicals such as peroxide or ozone in piping or reactors to oxidize organics. Also, UV-based enhanced photooxidation can similarly degrade organics dissolved in extracted water.	Dissolved VOCs and other organics in groundwater	Good Is effective for organics oxidation but can produce secondary byproducts that may need treatment such as ketones.	Good Technically implementable.	High	Retained for use as part of a treatment train Because it is an effective technology for VOCs and other organics in groundwater.
Ion Exchange	Uses ion exchange resins to adsorb anions or cations in groundwater to remove metals and other contaminants.	Dissolved metals, anions or cations in groundwater	Moderate to Good Effective for treatment of stormwater or treated water in ponds for discharge to storm drain (NPDES discharge).	Moderate to Good Technically implementable.	High	Not retained Because it is rated lower than reverse osmosis with respect to ability to handle high TDS.
Reverse Osmosis	Uses high pressure to push contaminated water through a semipermeable membrane that allows water to pass through but does not allow the contaminants such as dissolved metals or other inorganics/anions to pass through.	Dissolved metals and anions, TDS in groundwater	Good Effective for treatment of stormwater or treated water in ponds for discharge to storm drain (NPDES discharge).	Good Technically implementable.	High	Retained Because it is an effective technology for metals and high TDS in groundwater.

TABLE 9-4
SCREENING OF TECHNOLOGIES – EXTRACTED GROUNDWATER AND VAPOR TREATMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

TECHNOLOGY TYPE	DESCRIPTION	CONTAMINANT SCENARIO	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING COMMENTS
Membrane filtration - Vibratory Shear Enhanced Process (VSEP)	Uses membranes with nano or microfiltration techniques to remove fine particulate metal, inorganics or other contamination. VSEP is a vibrating membrane filtration process that is effective for metals and other inorganics.	Dissolved metals and other inorganics in groundwater	Good Effective for treatment of stormwater or treated water in ponds for discharge to storm drain (NPDES discharge).	Good Technically implementable.	Moderate to High	Retained Because it is an effective technology for metals in groundwater.
Oil-Water separator	Using oil-water separators to remove any extracted LNAPL or DNAPL prior to water treatment	Dissolved contaminants in groundwater NAPL	Good Effective for NAPL removal in extracted groundwater, especially LNAPL.	Good Technically implementable.	Moderate to High	Retained for use as part of a treatment train Because it is an effective technology for NAPL separation in groundwater.
Acidification/Neutralization	Acidification involves adding acid to reduce pH that is considered for use before the air stripper to keep solids in solution (reduce deposits in stripper). Neutralization is adding a base after air stripping prior to other treatment steps.	Dissolved VOCs and other organics in groundwater	Good Effective approach to keep metals and solids in solution in air stripper	Good Has been widely implemented in air stripping treatment.	Moderate to High	Retained for use with air stripping if needed.
EXTRACTED VAPOR TREATMENT TECHNOLOGIES						
Thermal oxidation - Thermal oxidizer - Internal Combustion Engine - Catalytic oxidizer - Catox + scrubber (for Cl-solvents) - Flameless thermal oxidizer	Treatment of extracted vapors containing hydrocarbons or VOCs by thermal destruction in oxidizers that burn fuels such as natural gas or propane. This includes oxidizers that destroy VOCs on heated catalysts which is also an effective option for chlorinated solvent vapors. Flameless oxidizers refer to VOC destruction on heated ceramic media without direct contact with the flame.	VOCs in extracted vapor	Good Technology is well proven.	Moderate to Good Some challenges may be encountered due to community concerns with formation of dioxins.	Moderate to High	Retained Because it is one of the most effective technologies for treatment of high VOC concentrations in the vapor phase.
Adsorption - Granular activated carbon (GAC) - Polymeric resin - VPGAC and Steam Regeneration	Treatment of extracted vapors by adsorption of hydrocarbons or VOCs in media such as vapor phase carbon or polymeric resins. The adsorption media is either taken offsite for recycling/reuse or regenerated onsite. Carbon can be regenerated on site using steam.	VOCs in extracted vapor	Good Technology is well proven. VPGAC is typically used at low vapor concentrations.	Good If onsite regeneration is selected, then waste steam such as VOC impacted groundwater and NAPL will need to be disposed off-site or treated onsite.	Moderate to High	Retained for GAC. Cost effectiveness is better at lower vapor concentrations. Onsite steam regeneration cost is very high but offsite regeneration is more cost effective. Resin systems have not been adopted widely because of cost and operational difficulties with regeneration.
Refrigeration/Condensation	Treatment of extracted vapors containing VOCs by cooling and compressing to condense and remove VOCs. Condensed contaminants are removed as liquids and either taken offsite for treatment/disposal or treated onsite.	VOCs in extracted vapor	Good This technology is not widely used in the site remediation field.	Moderate Only one vendor (GEO) is available	Very High	Not retained. Refrigeration systems are not commonly used in remediation applications but it may be a viable option if extracted Cl-VOC vapor is very high.
Acid scrubber	Treatment of extracted vapors containing acids (e.g. HCl from catalytic oxidizer) by an acid scrubber where the vapors are contacted with a spray of alkaline (e.g. NaOH) water to dissolve and neutralize the acid.	Acids in vapor	Good Technology is readily available.	Good Readily implementable.	High	Retained For specific application with catalytic oxidation of chlorinated vapors if needed.

TABLE 9-4
SCREENING OF TECHNOLOGIES – EXTRACTED GROUNDWATER AND VAPOR TREATMENT
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

NOTES

1. Definitions of Criteria :
   -Effectiveness is ability of the remedial technology to achieve the RAOs;
   -Implementability is a measure of the technical and administrative feasibility of constructing operating and maintaining a remedial alternative; and,
   -Cost refers to a relative cost compared with other technologies in same technology type. Costs will be refined later in the FS process.
2. Table uses a five-point rating scheme: Good, Moderate to Good, Moderate, Poor to Moderate, Poor.
   For Cost, the table uses a five-point rating scheme: Low, Low to moderate, Moderate, Moderate to High, High.
3. Retained technologies in table are identified as shaded rows.

TABLE 10-1
LIST OF REMEDIAL ALTERNATIVES FOR SCREENING ANALYSIS BY FS AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
1	**FS Area 1** PCB Landfill, Burial Trench Area (BTA), Central Drainage Area (CDA) and Existing Capped Landfills Area	Soil - Metals, Organics	- Protect Ecological-receptors - Minimize infiltration and control potential for groundwater contaminant migration - Stormwater and erosion controls	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring This alternative involves installing a RCRA cap for the PCB Landfill (4.4 acres) while capping the Burial Trench Area (BTA) (5.5 acres) and the Central Drainage Area (CDA) (about 18.8 acres) with 5 feet of a low permeability soil cap to prevent ecological-receptors from potential exposures to shallow soil (0-5' bgs) contaminants (Figure 11-1A). This low permeability soil cap would also minimize surface water infiltration into soil and groundwater in order to reduce further VOC migration in soil and groundwater and provide a clean storm water runoff. The stormwater will be directed by surface drains to a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site and then onto Pond 13 and off-site to the B-Drainage through or around the wetlands.
				3. Evapotranspirative (ET) Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA cap on the PCB Landfill (4.4 acres) and installing a ET soil cap on the Burial Trench Area (5.5 acres) and the Central Drainage (18.8 acres) as shown on Figure 11-2A. The ET soil cap is 5 feet of engineered low permeability claylike soil with a compacted 1-foot foundation layer and a 4-foot vegetative layer that is lightly compacted to about 85percent of maximum dry density (ASTM D 1557). The soil cap is intended to store water, allow growth of vegetation and removal of soil moisture through transpiration. These caps would be tied into the adjacent Capped Landfills Area. The RCRA cap and the ET cap prevents ecological-receptors from potential exposures to shallow soil (0-5' bgs) contaminants and significantly reduces rainwater infiltration into soil and groundwater in order to reduce further VOC migration in soil and groundwater. The stormwater will be directed by surface drains to a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site to Pond 13 and off-site to the B-Drainage through or around the wetlands.
				4. RCRA Cap (PCB Landfill, BTA, CDA) + Stormwater Controls + ICs + Monitoring This alternative would involve placing a RCRA cap on the PCB Landfill, BTA, and the CDA as shown on Figure 11-3A. This cap would prevent direct contact with metals and organic contaminants in shallow soil and address the risk to ecological-receptors. These caps would be tied into the adjacent Capped Landfills Area. The total surface area for each of these capped areas will be 4.4 acres for PCB Landfill, 5.5 acres for BTA, and 18.8 acres for CDA for a total of 28.7 acres of cap. The cap cross-section is assumed to be similar to the EE/CA Area cap. The stormwater will be directed by surface drains to a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site and then onto Pond 13 and off-site to the B-Drainage through or around the wetlands.
				5. Excavate (BTA, CDA remedial areas) (5')/Off-site Disposal + RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring This alternative addresses the shallow soil that poses a potential ecological risk and involves excavation of shallow soil within a portion of the BTA and CDA (2.5 acres and 5.5 acres, respectively). The areas targeted for excavation would be based on exceedances of the site-widesite-wide cleanup goals for metals and organics in shallow (0-5') soils. The PCB Landfill would be covered with a RCRA cap (4.4 acres) as in the other alternatives. The excavated soils will be sent off-site for disposal and backfilled with clean borrow soil from the Off-site NW Borrow Area. The stormwater will be directed by surface drains to a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site and then onto Pond 13 and off-site through or around the wetlands.
				6. Excavate (Entire BTA (20') + CDA remedial area (5'))/Off-site Disposal + RCRA-Equivalent Mono Soil Cap (BTA, CDA) + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring This alternative involves excavation of the entire footprint of the BTA (5.5 acres) to remove waste in trenches and the impacted shallow soils in the eastern of the CDA covering 6.2 acres (Figure 11-4A). This excavation would ensure that there is no potential risk for contact with chemicals of concern in shallow soil and would remove the waste material at the BTA as a potential source for deep soil and groundwater contamination. The excavated areas will be capped with a 5-foot thick low permeability RCRA-equivalent Mono soil cap to minimize infiltration across the entire BTA and CDA (24.3 acres). The stormwater will be directed by surface drains to a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site to Pond 13 and off-site through or around the wetlands.
2	**FS Area 2** RCRA Canyon, West Canyon Spray Area (WCSA)	Soil - Metals Storm Water - Metals	- Protect Ecological-receptors - Reduce infiltration and control potential for groundwater contaminant migration - Stormwater and erosion controls to separate clean capped area runoff for off-site discharge from uncapped area runoff - Eliminate seeps	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Ecological-Cap (West slope RCRA Canyon, WCSA remedial area) (2') + Grading/BMPs (Uncapped areas) + Stormwater Controls + ICs + Monitoring This alternative involves capping metals-impacted soils in the RCRA Canyon and WCSA which were identified as requiring remediation in the revised ERA (Appendix C of this FS) with an "ecological or ecological-cap" which is 2-foot of clean soil cover that is a vegetative layer (Figure 11-5A). The ecological cap would be placed in the RCRA Canyon west slope (8.4 acres) and over a portion of the WCSA east slope (5.5 acres). The ecological cap is intended to eliminate potential exposure to ecological-receptors. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. Some portions of the west slope and the WCSA that are steeper than 2:1 would be covered with turf reinforcement mats to minimize erosion. Since the ecological cap does not eliminate surface water infiltration or potential seeps at the foot of the RCRA Canyon, the stormwater from the entire RCRA Canyon/WCSA would be collected in an on-site evaporation pond where it would be managed.
				3. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon) (5') + Excavation (WCSA remedial area) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls (Segregate Capped and Uncapped Area SW) + ICs + Monitoring This remedial alternative involves installing a RCRA-equivalent mono (soil) cap on the Westslope of the RCRA Canyon which is approximately 8.4 acre. The RCRA-equivalent mono cap is 5-foot of low permeability claylike soil. The RCRA-equivalent cap will control potential exposures to ecological receptors and will reduce surface water infiltration. A portion of the WCSA (5.5 acres) will be excavated and the soil used as fill in Pond A-5 (Figure 11-6A). The excavated portions of the WCSA will be backfilled to match grades. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. The final surfaces of the western slope of the RCRA Canyon will be sloped and include surface drains to allow drainage of storm water from the Westslope of the RCRA canyon to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to the wetlands and discharged off-site to the B-Drainage via the General NPDES permit. The surface water runoff from the eastern slope of the RCRA Canyon (i.e. the WCSA) will be collected in an on-site evaporation pond which will be constructed in the footprint of the A-Series Pond where it would be managed.

TABLE 10-1
LIST OF REMEDIAL ALTERNATIVES FOR SCREENING ANALYSIS BY FS AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				4. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon, WCSA remedial area) (5') + Grading/BMPs (Uncapped areas) + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA equivalent mono (soil) cap on the west slope of the RCRA Canyon (8.4 acre) and a portion of the WCSA (5.5 acres) as shown on Figure 11-7A. The RCRA equivalent mono cap is 5-foot of low permeability claylike soil with a 4-foot compacted layer to meet the 10-6 cm/s permeability criterion and a top 1-foot vegetative layer that is compacted to 85percent of maximum dry density. The RCRA equivalent cap will control potential exposures to ecological receptors and will significantly reduce water infiltration. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. The final surfaces of the western slope of the RCRA Canyon and WCSA will be sloped and include surface drains to allow drainage of storm water from the west slope of the RCRA canyon and WCSA to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to through or around the wetlands and discharged off-site via the General permit. Grading and BMPs are included to reduce erosion in the uncapped areas (19.3 acres). The surface water runoff from the uncapped eastern slope of RCRA Canyon and WCSA will be collected in a new on-site evaporation pond where it would be managed.
				5. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon) (5') + Excavation (WCSA remedial area) (5') + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls (Segregate Capped and Uncapped Area SW) + ICs + Monitoring This remedial alternative involves installing a RCRA equivalent mono soil cap on the west slope of the RCRA Canyon which is approximately 8.4 acre as shown on Figure 11-8A. The RCRA equivalent mono cap is 5-foot of low permeability claylike soil with a 4-foot compacted layer to meet the 10^{-6} cm/s permeability criterion and a top 1-foot vegetative layer that is compacted to 85percent of maximum dry density. The RCRA equivalent cap will control potential exposures to ecological receptors and will minimize surface water infiltration. A portion of the WCSA will be excavated and the soil used as fill in Pond A-5. The excavated portions of the WCSA will be backfilled to match grades and compacted to achieve conductivities in the range of 10^{-4} to 10^{-6} cm/s. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. The uncapped remaining areas (19.3 acres) of the site will be graded to reduce slopes (max 2:1 slope) and covered with 2 feet of clean soil. The final surfaces of the west slope of the RCRA Canyon and the WCSA will be sloped and include surface drains to allow drainage of storm water from the entire RCRA canyon to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline through or around the wetlands and discharged off-site via the General permit.
				6. RCRA-equivalent Hybrid Cap (West slope RCRA Canyon) (5') + Excavation (WCSA remedial area) + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA-equivalent hybrid cap on the west slope of the RCRA Canyon which is approximately 8.4 acre as shown on Figure 11-9A. The RCRA equivalent hybrid cap is a spiked 60-mil HDPE liner, a geocomposite drainage layer, a biotic barrier and a 2-foot vegetative soil cover. The RCRA equivalent cap will control potential exposures to ecological receptors and will significantly reduce water infiltration. A portion of the WCSA will be excavated and the soil used as fill in Pond A-5. The excavated portions of the WCSA will be backfilled to match grades and compacted to 85percent relative compaction with a 1-foot vegetative layer on top. The uncapped remaining areas (19.3 acres) of the site will also be graded to reduce slopes (max 2:1 slope) and covered with 2 feet of clean soil. The stormwater will be collected by surface drains to a concrete channel that allows drainage into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline through or around the wetlands and discharged off-site via the General NPDES permit.
				7. Evapotranspirative (ET) Cap (West slope RCRA Canyon) (5') + Excavation (WCSA remedial area) + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a ET soil cap on the west slope of the RCRA Canyon which is approximately 8.4 acre as shown on Figure 11-10A. The ET soil cap is 5 feet of engineered low permeability claylike soil that includes a vegetative layer that is 4 feet thick that is lightly compacted to about 85percent relative compaction and a 1-foot thick compacted foundation layer. The soil cap is intended to store water, allow growth of vegetation and removal of soil moisture through transpiration. This ET cap will control potential exposures to ecological receptors and will reduce surface water infiltration. A portion of the WCSA will be excavated and the soil used as fill in Pond A-5. The excavated portions of the WCSA will be backfilled to match grades and compacted to 90percent relative compaction with a lightly compacted vegetative layer on top. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas (2:1) in order to install the cap. The uncapped remaining areas (19.3 acres) of the site will also be graded to reduce slopes (max 2:1 slope) covered with 2 feet of clean soil. The final surfaces of the west slope of the RCRA Canyon and the WCSA will be sloped and include surface drains to allow drainage of storm water from the entire RCRA canyon to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline through or around the wetlands and discharged off-site via the General permit.
				8. RCRA Equivalent Hybrid Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA equivalent hybrid cap on the entire RCRA Canyon and WCSA that is a total of 33 acres. The RCRA equivalent hybrid cap uses a HDPE liner with spikes, a geocomposite drainage layer, a biotic barrier and a 2-foot vegetative soil cover (Figure 11-11A). The RCRA equivalent cap will control potential exposures to ecological receptors and will significantly reduce water infiltration. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. The final surfaces of the western slope of the RCRA Canyon and WCSA will be sloped and include surface drains to allow drainage of storm water from the Westslope of the RCRA canyon and WCSA to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline through or around the wetlands and discharged off-site via the General NPDES permit. The surface water runoff from the uncapped eastern slope of RCRA Canyon and WCSA will be collected in a new on-site evaporation pond where it would be managed.
				9. Evapotranspirative (ET) Cap (entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing an ET cap on the entire RCRA Canyon and WCSA that is a total of 33 acres as shown on Figure 11-12A. The ET soil cap is 5 feet of engineered low permeability claylike soil that includes a vegetative layer that is 4 feet thick that is lightly compacted to about 85percent relative compaction and a 1-foot thick compacted foundation layer. The soil cap is intended to store water, allow growth of vegetation and removal of soil moisture through transpiration. This ET cap will control potential exposures to ecological receptors and will reduce surface water infiltration. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. The final surfaces of the western slope of the RCRA Canyon and WCSA will be sloped and include surface drains to allow drainage of storm water from the west slope of the RCRA canyon and WCSA to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline through or around the wetlands and discharged off-site via the General permit. The surface water runoff from the uncapped south end of the WCSA will be collected in a new on-site evaporation pond where it would be managed.

TABLE 10-1
LIST OF REMEDIAL ALTERNATIVES FOR SCREENING ANALYSIS BY FS AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				10. RCRA Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring This alternative involves constructing a RCRA cap in the entire RCRA Canyon (36.29 acres) to control potential exposure to ecological receptors. The RCRA cap is similar to the existing cap in the Capped Landfills Area and will prevent infiltration into groundwater. The final capped surface would be sloped and would incorporate surface drains to allow drainage of storm water through Pond A-5 and Pond 13 through or around the wetlands as clean runoff in accordance with the General NPDES permit.
3	**FS Area 3** Former Pond and Pads, Roadways, Remaining On-site Areas, Maintenance Shed Area, Liquids Treatment Area	Soil - Metals, Organics - 9 hotspot locations with Tier 1 ecological-risk exceedances - 1 hotspot RISBON-59 as potential groundwater contaminant	- Protect Ecological receptors - Reduce infiltration and control potential for groundwater contaminant migration - Stormwater and erosion controls	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Ecological-Cap (Locations 2, 3, 4) (2') + New Asphalt Cap (Location 1) + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This alternative involves placing an ecological-cap with 2' vegetative soil cover on Locations 2, 3, and 4, covering a total area of 6.5 acres. A simple cap (asphalt cap) will be placed on Location 1 (1 acre). Groundwater will be monitored at Location 10 (0.7 acres). For Locations 1 and 10, this alternative assumes monitoring of asphalt cap and groundwater respectively.
				3. RCRA Cap (Locations 2, 3, 4)[2] + Excavate/New Asphalt Cap (Location 1) (5') + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This remedial alternative involves extending the RCRA cap which is discussed for Area 1 over the Maintenance Shed Area (Location 2) and Hotspot Locations 3 and 4 south of the PSCT (Figure 11-13A). This RCRA cap will extend for approximately 300 feet south of the PSCT and run parallel to it over Locations 3 and 4. The surface of the cap is sloped and includes surface drains to direct stormwater on the cap to flow southeast towards the drainage channel near PSCT-1. The stormwater in the drainage channel will flow under a culvert on RCF Road to Pond 13 and then off-site through the wetlands under the site's General NPDES permit. Portions of Hotspot Location 1 that are not already covered by asphalt or concrete will be excavated and the entire location will be paved with a new 4" asphalt cap. For Hotspot Location 10 (RISBON-59), the remedial alternative proposes two additional Upper HSU downgradient groundwater monitoring wells to ensure that there is no impact in the future to groundwater from this deep soil impacted area.
				4. RCRA Cap (Locations 2)[2] + Excavate ((Location 3) (20'); (Location 4) (5')) + Excavate/New Asphalt Cap (Location 1) (5') + Groundwater Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This remedial alternative involves extending the RCRA cap which is discussed for Area 1 over the Maintenance Shed Area (Location 2) and excavation of Hotspot Locations 3 and 4 south of the PSCT for disposal in the PCB Landfill (Figure 11-14A). The excavation will be backfilled with clean borrow soil. The surface of the cap would be sloped and includes surface drains to direct stormwater on the cap to flow southeast towards the drainage channel near PSCT-1. The stormwater in the drainage channel will flow under a culvert on RCF Road to Pond 13 and then off-site through the wetlands under the site's General NPDES permit. Hotspot Location 1 will be excavated and paved with a new 4" asphalt cap. For Hotspot Location 10 (RISBON-59), the remedial alternative proposes two additional Upper HSU downgradient groundwater monitoring wells to ensure that there is no impact in the future to groundwater from this deep soil impacted area.
				5. RCRA Cap (Location 2) + Excavate ((Location 3) (20'); (Location 4) (5'); (Location 10) (50'))/Place in PCB Landfill + Excavate/New Asphalt Cap (Location 1) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This remedial alternative involves extending the RCRA cap which is discussed for Area 1 over the Maintenance Shed Area (Location 2) and excavation of Hotspot Locations 3 and 4 south of the PSCT for disposal in the PCB Landfill (Figure 11-15A). The excavation will be backfilled with clean borrow soil. The surface of the cap would be sloped and includes surface drains to direct stormwater on the cap to flow southeast towards the drainage channel near PSCT-1. The stormwater in the drainage channel will flow under a culvert on RCF Road to Pond 13 and then off-site through the wetlands under the site's General NPDES permit. Hotspot Location 1 will be excavated and paved with a new 4" asphalt cap. For Hotspot Location 10 (RISBON-59), the alternative includes excavation of an area about 175 feet by 175 feet with a total depth of 50 feet below RCF Road for a total impacted soil volume of 65,000 cy for on-site disposal at the PCB Landfill.
				6. Excavate (Locations 2, 4) (5')/Place in PCB Landfill + Excavate (Location 3) (20')/Off-site Disposal + Excavate/Asphalt Cap (Location 1) (5') + In-situ Thermal Desorption (Location 10) (5'-50' bgs) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This alternative involves excavation of the top 5 feet of Locations 1, 2, 3 and 4 covering an area of 8.5 acres and a total of 70,000 cy, and in-situ thermal desorption (ISTD) at Location 10 (0.7 acres, 175 feet by 175 feet) with a total depth of 50 feet bgs under NTU Road. ISTD for Location 10 involves closely spaced electric heater wells that heat the subsurface soils and also act as soil vapor extraction wells. The excavated area of Location 1 would be backfilled and covered with a new asphalt cap. The excavated soil would be disposed off-site at a Class I landfill.
				7. Excavate (Locations 2, 4) (5') + Excavate (Location 3) (20') and (Location 10) (50')/Off-site Disposal + Excavate/Asphalt Cap (Location 1) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This alternative involves excavation of the top 5 feet of Locations 1, 2, and 4 (total area of 8.5 acres, total volume of 70,000 cy), excavation of Location 3 to 20 feet, and Location 10 (area of 0.7 acres, volume of 56,000 cy) with a total excavation depth of 50 feet bgs under NTU Road (Figure 11-16A). The excavated area of Location 1 would be backfilled and covered with an asphalt cap. The total excavated soil volume at all locations would be approximately 126,000 cy for disposal at an off-site landfill. These excavations are backfilled with clean soil imported from off-site sources due to the large amount of fill needed. After backfilling Location 1 will be covered with an asphalt cap. The stormwater runoff from these backfilled areas will be graded such that the stormwater sheet flows towards the southern portion of the site to Pond 13 and then off-site through or around the wetlands under the site's General permit.
4	**FS Area 4** Ponds RCF, A-series, 18, A-5, 13	Surface Water, Sediment - Metals, Organics	- Protect Ecological receptors and Human receptors (on-site workers, trespassers) - Reduce infiltration and control potential for	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Ecological-Cap (RCF, A-Series Pond) (2') + Construct New 11-Acre Evaporation Pond + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This remedial alternative involves managing existing storm water in the A-Series Pond and RCF Pond as discussed in the body of the FS to reduce or eliminate those volumes prior

TABLE 10-1
LIST OF REMEDIAL ALTERNATIVES FOR SCREENING ANALYSIS BY FS AREA
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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
			groundwater contaminant migration - Stormwater and erosion controls	to FS construction. The impacted bottom areas of the RCF and A-Series Pond sediments will be raised to 415 feet bgs and 425 feet bgs respectively and capped with an ecological-cap (discussed previously) which is comprised of a 2-foot soil vegetative soil cover . The remedial alternative assumes the construction of a new lined 11-acre evaporation pond south of the PSCT (Figure 11-17A). A new lined retention basin will be constructed in the footprint of Pond A-5 (2.13 acres), which will be partially backfilled to ensure the pond bottom is above projected groundwater levels. Pond18 will be backfilled to match surface grades and ensure storm water flows off that area of the site and will be capped with a RCRA cap. Pond 13 (1.94 acres) will be incorporated into the current wetlands pool system and will be partially backfilled filled using the Pond 13 dike and then lined with a HDPE material similar to the proposed drainage channels used to transport stormwater.
				3. Ecological-Cap (RCF Pond, Segregate East RCF) (2') + Construct Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This alternative involves managing liquids in the existing stormwater ponds as discussed in detail in the FS (the management plan utilizes a new lined evaporation pond which is constructed in the footprint of the A-Series Pond). The RCF Pond (11.4 acres) is lined with an ecological-cap after it is drained and partially filled to raise the western portion of the pond bottom to 415 feet MSL while the east end of the RCF is segregated with a 5-foot high berm (Figure 11-18A). The A-Series Pond (11 acres) bottom is raised to 425 ft MSL with fill soil from the northeast shore line (which also serves to expand the size of the new evaporation pond to 11 acres). The A-Series Pond bottom is then lined with a geocomposite HDPE liner to convert it to the evaporation pond. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. Pond A-5 and 13 (total area of 4.07 acres) are filled to raise the pond bottom and then lined to serve as retention basins that drain storm water to the wetlands that discharge off-site to the B-Drainage under the site's General permit.
				4. Ecological-Cap (RCF Pond) (2') + Construct 11-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls[3, 4] + ICs + Monitoring This alternative involves managing liquids in the existing stormwater ponds as discussed in detail in the FS. The RCF Pond is lined with an ecological-cap after it is drained and the pond bottom is raised to 415 feet MSL with borrow soil (Figure 11-19A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line (which also serves to expand the size of the new evaporation pond to 11 acres). The A-Series Pond bottom is then lined with a geocomposite HDPE liner to convert it to the evaporation pond. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The other ponds (Pond A-5 and 13) are filled to raise the pond bottom and then lined to serve as retention basins that drain storm water to the wetlands that discharge off-site to the B-Drainage under the site's General NPDES permit.
				5. Ecological-Cap (RCF Pond, portion of A-Series Pond) + Construct 6-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This alternative involves managing liquids in existing stormwater ponds as discussed in detail in the FS. The RCF Pond is lined with an ecological-cap after it is drained and the bottom raised to 415 feet MSL across the entire pond (Figure 11-20A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line and a portion of the A-Series Pond is then converted to a 6-acre lined evaporation pond using a geocomposite HDPE liner with the remaining area (5 acres) covered with an ecological-cap. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The ecological-caps on the RCF and A-Series Ponds would be sloped to direct stormwater towards Pond 13 and then to the wetlands. The other ponds (Pond A-5 and 13) are backfilled with soil and lined to serve as retention basins to drain storm water to the wetlands that discharge off-site to the B-Drainage under the site's General NPDES permit.
				6. Ecological-Cap (RCF Pond, A-Series Pond) (2') + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls[3, 4] + ICs + Monitoring This alternative involves managing liquids in the existing stormwater ponds as discussed in the FS. This alternative does not include an evaporation pond and complements the remedial alternatives in Area 5 groundwater where the groundwater is treated for both VOCs and inorganics. The RCF Pond is lined with an ecological-cap after it is drained and the pond bottom is raised to 415 feet MSL with borrow soil (Figure 11-21A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line and then covered with an ecological-cap. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The other ponds (Pond A-5 and 13) are filled to raise the pond bottom and then lined to serve as retention basins that drain storm water to the wetlands and then off-site to the B-Drainage under the site's General NPDES permit.
				7. ET Cap (RCF Pond, portion of A-Series Pond) + Construct 6-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This alternative involves managing liquids in existing stormwater ponds as discussed in detail in the FS. The RCF Pond is lined with an ET cap after it is drained and the bottom raised to 415 feet MSL (Figure 11-22A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line. A portion of the A-Series Pond is then converted to a 6-acre lined evaporation pond using a geocomposite HDPE liner. The remaining portion (5 acres) of the A-Series Pond is covered with an ET cap. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The other ponds (Pond A-5 and 13) are backfilled with soil and lined to serve as retention basins to drain storm water to the wetlands that discharge off-site to the B-Drainage under the site's General NPDES permit.
				8. Excavate/Clean Backfill (RCF Pond, A-Series Pond) + Construct New 11-Acre Lined Evaporation Pond (North of RCF Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This alternative involves constructing a new 11-acre lined evaporation pond north of the RCF Pond and managing the existing stormwater in the ponds by pumping the remaining stormwater to the new evaporation pond. After emptying the two ponds, the RCF and A-Series Pond (22.4 acres total) sediments are excavated between 2 to 5 feet below surface to address metals contamination and backfilled/graded to ensure the stormwater flows out of the ponds through the culvert under RCF Road (Figure 11-23A). Additional backfill soil would be needed on the eastside of the RCF to ensure there is adequate slope to drain water to the culvert under RCF Road. From this culvert, the stormwater would then go through Pond 13 to the wetlands and off-site B-drainage under the site's General permit.
				9. RCRA Cap (RCF Pond, Pond 18) (5') + Construct New 11-Acre Lined Evaporation Pond (A-Series Pond) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This alternative involves managing liquids in existing stormwater ponds as discussed in detail in the FS. The RCF Pond (11.4 acres) is lined with a RCRA cap after it is drained and the bottom is raised to 415 feet bgs. The A-Series Pond (11 acres) bottom is raised to 425 feet MSL with fill soil from the northeast shore line that is excavated to expand to cover 11 acres. The A-Series Pond is then converted to an 11-acre lined evaporation pond using a geocomposite HDPE liner. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. Ponds A-5 and 13 (total area of 4.1 acres) are backfilled with soil and lined to serve as retention basins to drain storm water to

TABLE 10-1
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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				the wetlands that discharge off-site to the B-Drainage under the site's General permit.
5	**FS Area 5 North** Groundwater	Groundwater - VOCs, Inorganics, LNAPL, DNAPL	- Contain and/or control contamination sources within the proposed TI waiver zone - Protect off-site groundwater resources - Mitigate potential off-site migration of groundwater contamination by perimeter control - Contain and/or control migration of DNAPL in source areas where removal is not technically practicable - Remove DNAPL in source areas where extraction is practical and where significant reduction in risk will result. - Contain and/or control the migration of LNAPL in source areas	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Extraction (PSCT, Gallery Well) + Treat and Discharge PSCT Groundwater to On-site Evaporation Pond + ICs + Monitoring This remedial alternative includes continued extraction of liquids and NAPL from Gallery Well and PSCT extraction features as is required to meet current action levels (Figure 11-24A). The NAPL and liquids from the Gallery Well would be sent to an off-site TSDF for disposal similar to how they are currently managed. The PSCT liquids would be treated on-site for removal of organics (via an upgraded GAC system). The treated PSCT liquids will be pumped to the new lined evaporation pond which is proposed to be located in the footprint of the A-Series Pond. Site-wideSite-wide groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				3. Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 new Lower HSU wells) + Treat and Discharge PSCT Groundwater to On-site Evaporation Pond + ICs + Monitoring This alternative includes continued extraction of liquids and NAPL from the Gallery Well and PSCT trenches as discussed in Alternative 2. In addition, this alternative adds NAPL-only extraction from 16 new NAPL-only wells in the Upper HSU under the P/S Landfill. Four wells will be located on Bench 1 and four more on a new bench road between Bench 1 and Bench 2. In addition, two new bench roads south of Bench 1 will have four wells each near the toe of the P/S Landfill (Figure 11-25A). NAPL-only extraction anticipates utilizing 4-inch diameter wells which are pumped as necessary when sufficient DNAPL and LNAPL has collected in the well. Also, four existing monitoring wells in the CDA would be converted to LNAPL skimmer wells to recover floating product. Twelve new Lower HSU monitoring wells are proposed just upgradient of PSCT-1 and PSCT-4 to monitor the any potential VOC migration under the PSCT in the Lower HSU. The PSCT liquids would be treated on-site for removal of organics (via an upgraded GAC system) and pumped to a new upgraded on-site treatment system designed to remove organics. The treated PSCT liquids will be pumped to a new lined evaporation pond in the A-Series Pond footprint as in Alternative 2. The extracted NAPL and aqueous leachate will be sent off-site to a permitted facility for disposal. Site-wide groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				4. Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 new Lower HSU wells) + Treat and Discharge PSCT Groundwater Off-site (No Evaporation Pond) + ICs + Monitoring This alternative includes continued extraction of liquids and NAPL from the Gallery Well and PSCT trenches and NAPL-only extraction as discussed in Alternative 3. Also, as in Alternative 3, four existing monitoring wells in the CDA would be converted to LNAPL skimmer wells to recover floating product and twelve new Lower HSU monitoring wells are proposed just upgradient of PSCT-1 and PSCT-4 to monitor the any potential VOC migration under the PSCT in the Lower HSU. However, in this alternative, the PSCT liquids would be treated on-site for removal of organics and inorganics using carbon adsorption, and reverse osmosis for off-site discharge to the B-Drainage in accordance with the site-specific NPDES permit (Figure 11-26A). This alternative assumes that there is no evaporation pond on-site. The extracted DNAPL and leachate will be sent off-site to a permitted facility for disposal. Site-wide groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				5. Extraction (PSCT, Gallery Well) + Extraction (Aggressive, 16 Large Diameter NAPL wells) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 new Lower HSU wells) + Treat and Discharge to On-site Evaporation Pond + ICs + Monitoring This alternative includes continued extraction of liquids and NAPL from Gallery Well and PSCT trench extraction as it is currently being implemented. This alternative adds continuous aggressive total fluids extraction from 16 new large-diameter (8") NAPL wells in the vicinity of RIPZ-13 in the P/S landfill in the Upper HSU (Figure 11-27A). Four wells will be located on Bench 1 and four more on a new bench road between Bench 1 and Bench 2. In addition, two new bench roads south of Bench 1 will have four wells each near the toe of the P/S landfill. Also, as in Alternative 3, four existing monitoring wells in the CDA would be converted to LNAPL skimmer wells to recover floating product and twelve new Lower HSU monitoring wells are proposed just upgradient of PSCT-1 and PSCT-4 to monitor the any potential VOC migration under the PSCT in the Lower HSU. The aggressive extraction of total fluids is expected to produce an average flow rate of up to10 gpm of landfill leachate that is treated in a new Liquids Treatment Plant (LTP) which removes organics. The treated leachate from the LTP along with the treated PSCT liquids will be discharged to a new evaporation pond located north of the RCF Pond to handle the additional volumes of treated liquids. Site-wide groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				6. Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 new Lower HSU wells) + Treat and Discharge to On-site Evaporation Pond + ICs + Monitoring This alternative includes extraction from the PSCT and Gallery Well and adds 5 horizontal wells under the P/S Landfill to dewater it (Figure 11-28A). The horizontal well extraction of total fluids is expected to produce a total groundwater flow rate of up to 10 gpm of landfill leachate (initially) and decreasing in subsequent years. The PSCT groundwater would be treated in a new Liquids Treatment Plant (LTP) for VOCs and discharged to the on-site evaporation pond. Also, as in Alternative 3, four existing monitoring wells in the CDA would be converted to LNAPL skimmer wells to recover floating product and twelve new Lower HSU monitoring wells are proposed just upgradient of PSCT-1 and PSCT-4 to monitor the any potential VOC migration under the PSCT in the Lower HSU. The dewatered landfill liquids are not treated on-site. They are transported off-site for disposal at a permitted facility along with extracted NAPL from the Gallery Well. Site-wide groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				7. Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells) + Extraction (NAPL-only in CDA, 12 new wells) + Extraction (4 new Lower HSU wells) + Monitoring (8 new Lower HSU wells) + Treat and Discharge Off-site + ICs + Monitoring This alternative includes extraction from the PSCT and Gallery Well and adds 5 horizontal wells under the P/S Landfill to dewater it (Figure 11-29A). The horizontal well extraction of total fluids is expected to produce a total groundwater flow rate of up to 10 gpm of landfill leachate (initially) and decreasing in subsequent years. The PSCT groundwater would be treated in a new Liquids Treatment Plant (LTP) for VOCs and inorganics and discharged off-site to the B-Drainage. Also, as in Alternative 3, four existing monitoring wells in the CDA would be converted to LNAPL skimmer wells to recover floating product, four new Lower HSU wells are proposed just upgradient of PSCT-1 and PSCT-4 for groundwater

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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				extraction and eight new Lower HSU wells are proposed for monitoring to prevent any potential VOC migration under the PSCT. The dewatered landfill liquids are not treated on-site. They are transported off-site for disposal at a permitted facility along with extracted NAPL and liquids from the Gallery Well. Site-wide groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				8. Aggressive Extraction (50 New Large Diameter Extraction Wells, Area 5 North) + Extraction (Aggressive, 16 Large Diameter NAPL Wells in P/S Landfill) + Extraction (PSCT, Gallery Well) + Treat and Discharge Off-site + ICs + Monitoring This alternative is an aggressive hydraulic extraction that would require a high density of groundwater extraction wells be installed with the objective of achieving MCLs in groundwater throughout the site. The alternative would be required if a Technical Impracticability waiver is not granted by USEPA. It would involve installation of a total of 50 new extraction wells that includes 40 wells in the Upper HSU and 10 wells in the Lower HSU. The wells will be distributed at a spacing of about 150 feet across the most impacted groundwater of Area 5 North. Extraction from these wells would be continuous and is assumed to produce about 0.5 gpm per well for a total of about 25 gpm and another 10 gpm from aggressive extraction in P/S Landfill with VOC, NAPL, other organics and metals-impacted groundwater being treated aboveground in a dedicated treatment system for discharge off-site in accordance with a site-specific NPDES permit.
5	**FS Area 5 South** Groundwater	Groundwater - VOCs, Inorganics (As, Cd, Ni, Se)	- Contain and/or control contamination sources within the proposed TI waiver zone - Protect off-site groundwater resources - Mitigate potential off-site migration of groundwater contamination by perimeter control	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Extraction (PCT-A, PCT-B)[5] + Treat/Discharge to On-site Evaporation Pond + MNA + ICs + Monitoring This remedial alternative includes continued extraction of liquids from PCT-A and PCT-B as is required to meet current action levels to ensure no off-site migration. The extracted PCT-A and PCT-B liquids will be treated for organics (if needed) and pumped to a new lined evaporation pond proposed to be located in the footprint of the A-Series Pond (Figure 11-30A). Note that anticipated capping remedies for the FS Areas and 1 and 3 would minimize leaching to groundwater. This combined with natural attenuation of organics would reduce contaminant concentrations over the long term. Groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				3. Extraction (PCT-A, PCT-B)[5] + Treat and Discharge Off-site + MNA + ICs + Monitoring This remedial alternative includes continued extraction of liquids from PCT-A and PCT-B as in Alternative 2. The extracted PCT-A and PCT-B liquids will be treated for organics and inorganics and discharged off-site in accordance with the site-specific NPDES permit (Figure 11-31A) which would require a Basin Plan exemption. The treatment will include reverse osmosis for inorganics and if needed, LPGAC for organics. The reverse osmosis used to treat inorganics produces waste brine that is assumed to be sent off-site for disposal. Note that anticipated capping remedies for the FS Areas and 1 and 3 would minimize leaching to groundwater. This combined with natural attenuation of organics would reduce contaminant concentrations over the long term. Groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				4. Extraction (PCT-A) + In-situ Reactive Wall (PCT-B) + MNA + ICs + Monitoring This alternative assumes that the PCT-B trench is converted to a passive, in-situ reactive wall treatment using ZVI instead of extraction (Figure 11-32A) and extraction at the PCT-A. The extracted PCT-A liquids will be pumped to a new lined evaporation pond which we are proposing to be located in the footprint of the A-Series Pond. The in-situ reactive wall is constructed by cutting four slots in the clay barrier along the trench. Note that anticipated capping remedies for the FS Areas and 1 and 3 upgradient of PCT-B would minimize leaching to groundwater. This combined with natural attenuation of organics would reduce contaminant concentrations over the long term. Groundwater monitoring is included as described in the RGMEW work plan March 2009.
				5. Extraction (PSCT Westside Extension) + Extraction (PCT-A, PCT-B) + MNA + ICs + Monitoring This alternative includes construction of the PSCT Westside extension and continued extraction at the PCT-A and PCT-B. The PSCT liquids would be treated in the GWTS with LPGAC as currently implemented. The treated PSCT liquids and extracted PCT-A and PCT-B liquids would be pumped to a new lined 11-acre evaporation pond located in the footprint of the A-Series Pond. This alternative includes monitoring of groundwater site-wide to document natural attenuation organics and other contaminants via intrinsic biodegradation and other mechanisms and the institutional controls to protect potential for exposures such as deed restrictions. . This alternative also includes the anticipated capping of areas south of the PSCT (FS Area 3) that are sources of VOCs and inorganics in Area 5 South.
				6. Aggressive Extraction (40 New Large Diameter Wells, Area 5 South) + Extraction (PCT-A, PCT-B) + Treat and Discharge Off-site + MNA + ICs + Monitoring This alternative is an aggressive hydraulic extraction that would require a high density of groundwater extraction wells be installed as an attempt to achieve MCLs in groundwater throughout the site. The alternative would be required since a Technical Impracticability waiver is not included for this groundwater area. It involves installation of 40 new large diameter extraction wells distributed across Area 5 South at approximately 150-foot spacing (Figure 11-33A). Extraction from these wells would be continuous and is assumed to produce about 0.5 gpm per well and the PCT flows and be handled by a treatment system designed for 30 gpm of low VOCs and inorganics-impacted groundwater being treated aboveground in a dedicated treatment system for discharge off-site in accordance with a site-specific NPDES permit. Extraction at the PCT-A and PCT-B is also included to provide capture at the perimeter. Note that anticipated capping remedies for the FS Areas and 1 and 3 upgradient of PCT-A and PCT-B would minimize leaching to groundwater. This combined with natural attenuation of organics would reduce contaminant concentrations over the long term. The extracted groundwater is treated at a centralized treatment system at the LTA and is assumed to include LPGAC for organics and reverse osmosis for inorganics. The treated groundwater is discharged off-site under a site-specific NPDES permit which would require a Basin Plan exemption. The waste brine from reverse osmosis is sent off-site for disposal.
6	**FS Area 5 West** Groundwater	Groundwater – Inorganics (As, Cd, Ni, Se)	- Contain and/or control contamination sources within the site boundary, where groundwater restoration is not technically practicable	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Monitored Natural Attenuation + ICs This alternative involves monitoring of groundwater site-wide to document natural attenuation via intrinsic biodegradation and other mechanisms and the institutional controls to protect potential for exposures such as deed restrictions. Note that anticipated capping remedy for RCRA Canyon/WCSA (FS Area 2) and pond closure remedy for Pond A-5 and A-Series Pond (FS Area 4) would minimize leaching to groundwater and would reduce inorganic concentrations over the long term.

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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
			- Protect off-site groundwater resources - Mitigate potential off-site migration of groundwater contamination by perimeter control	**3. Extraction (PCT-C) + Treat and Discharge to On-site Evaporation Pond MNA + ICs + Monitoring** This remedial alternative includes continued extraction of liquids from PCT-C as is required to meet current action levels to prevent off-site migration. The extracted PCT-C liquids will be pumped to the new lined evaporation pond which we are proposing be located in the footprint of the A-Series Pond (Figure 11-34A). Note that anticipated capping remedies for RCRA Canyon/WCSA (FS Area 2) and Pond A-5 and A-Series Pond (FS Area 4) that are upgradient would minimize leaching to groundwater and this would attenuate inorganic concentrations over the long term. Groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				4. Extraction (PCT-C) + Treat and Discharge Off-site + MNA + ICs + Monitoring This remedial alternative includes continued extraction of liquids from PCT-C as in Alternative 2. The extracted PCT-C liquids will be treated for inorganics and discharged off-site in accordance with the site-specific NPDES permit (Figure 11-35A). A Basin Plan exemption would be required for the discharge to the B-Drainage. The treatment technology would include reverse osmosis for inorganics and if needed LPGAC for organics (if any). The reverse osmosis produces waste brine that is assumed to be sent off-site for disposal. Note that anticipated capping remedies for RCRA Canyon/WCSA (FS Area 2) and Pond A-5 and A-Series Pond (FS Area 4) that are upgradient would minimize leaching to groundwater and this would attenuate inorganic concentrations over the long term. Groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				5. In-Situ Reactive Wall (PCT-C) + MNA + ICs + Monitoring This alternative assumes that the PCT-C trench is converted to a passive, in-situ reactive wall treatment using ZVI instead of extraction (Figure 11-36A). It is constructed by cutting four slots in the clay barrier along the 1,500-foot length of the trench. Note that anticipated capping remedies for RCRA Canyon/WCSA (FS Area 2) and Pond A-5 and A-Series Pond (FS Area 4) that are upgradient would minimize leaching to groundwater and this would attenuate inorganic concentrations over the long term. Groundwater monitoring is included as currently implemented and described in the RGMEW work plan dated March 2009.
				6. Aggressive Extraction (40 new extraction wells) + Extraction (PCT-C) + Treat and Discharge Off-site + MNA + ICs + Monitoring This alternative is an aggressive hydraulic extraction that would require a high density of groundwater extraction wells be installed as an attempt to achieve MCLs in groundwater throughout the site. The alternative would be required since a Technical Impracticability waiver is not included for this groundwater area. It involves installation of 40 new large diameter extraction wells distributed across Area 5 West at approximately 150-foot spacing (Figure 11-37A). Extraction from these wells would be continuous and is assumed to produce about 0.05 gpm per well and including the PCT-C flow, the system is designed for a total of about 20 gpm of inorganics-impacted groundwater being treated aboveground in a dedicated treatment system for discharge off-site in accordance with a site-specific NPDES permit. The off-site discharge would require a Basin Plan exemption. The treatment technology would include reverse osmosis for inorganics and LPGAC for organics (if any). The reverse osmosis produces waste brine that is assumed to be sent off-site for disposal. Extraction of the PCT-C is assumed to be included to provide capture at the perimeter. Note that anticipated capping remedies for RCRA Canyon/WCSA (FS Area 2) and Pond A-5 and A-Series Pond (FS Area 4) that are upgradient of PCT-C would minimize leaching to groundwater and would attenuate inorganic concentrations over the long term.

NOTES

1. All caps include drainage controls in order to satisfy the site wide storm water objectives.
2. The Capping alternative includes demolishing the Maintenance Shed Area building and removing the two USTs currently present in the subsurface.
3. Stormwater plan is to transport the clean storm water to or around the wetlands that discharge to off-site B-Drainage in accordance with the site's General Permit. The discharge to the wetlands for RCRA canyon stormwater is via a stormwater conveyance pipe and the drainage for the Capped Landfills Area is via a drainage channel through the RCF Pond footprint to the wetlands.
4. The alternatives that require off-site discharge of treated groundwater would require a site-specific NPDES permit that would need a Basin Plan exception from the RWQCB.
5. Extraction flow rates at PSCT and PCT-A decrease with anticipated increased capping and closing of ponds as part of the remedy that reduces rainwater infiltration.

TABLE 10-2
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 1 - PCB LANDFILL, BURIAL TRENCH AREA, CENTRAL DRAINAGE AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
1	**No Action**	**POOR** - Because the risk to ecological receptors in shallow soil and the potential for further rainwater infiltration and contaminant migration in groundwater would still exist.	**NOT APPLICABLE**	**NONE**	**NONE**	**RETAINED** - Because it is required by the NCP.
2	**RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - Because the soil cap can eliminate potential exposures to ecological receptors - Prevent rainwater infiltration through the PCB Landfill and minimize infiltration through BTA and CDA which would minimize migration of organic and inorganic contaminants in groundwater. - Clean stormwater from these capped areas can be directed off-site under the site's General NPDES permit.	**GOOD** - Because more complex RCRA caps have been successfully implemented in this area before. - Minor technical challenges with capping in areas with steep slopes. This will require significant cut/fill grading volume especially for the CDA.	**MODERATE TO HIGH** - Borrow soil from off-site NW Borrow Area for cap construction is assumed. - Borrow soil is claystone material that will need pre-processing to achieve the low permeability compacted soil cap.	**MODERATE** - Green and sustainability impacts are based on cut/fill grading of 120,000 cy and borrow soil/compaction for caps of 250,000 cy - Materials manufacture, transport, installation (4.4 acres HDPE, GCL liner, Biotic barrier) - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - Because it can achieve the remedial objectives and there are no significant implementability challenges.
3	**Evapotranspirative (ET) Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - Because the soil cap can eliminate potential exposures to ecological receptors - Prevent rainwater infiltration through the PCB Landfill, and minimize infiltration through BTA and CDA which would minimize migration of organic and inorganic contaminants in groundwater. - Clean stormwater from these capped areas can be directed off-site under the site's General NPDES permit.	**GOOD** - Because more complex RCRA caps have been successfully implemented in this area before. - Minor technical challenges with capping in areas with steep slopes. This will require significant cut/fill grading volume especially for the CDA.	**MODERATE TO HIGH** - Borrow soil from off-site NW Borrow Area for cap construction is assumed. - Some pre-processing of soils and addition of amendments would be required to meet the requirements of the vegetative and foundation layer.	**MODERATE** - Green and sustainability impacts are based on cut/fill grading of 120,000 cy and borrow soil/compaction for caps of 250,000 cy - Materials manufacture, transport, installation (4.4 acres HDPE, GCL liner, Biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies and helps empty ponds for subsequent Area 4 remedy.	**RETAINED** - Because it can achieve the remedial objectives and there are no significant implementability challenges.
4	**RCRA Cap (PCB Landfill, BTA, CDA) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - Because the RCRA cap can eliminate potential exposures to ecological receptors - Prevent rainwater infiltration through the PCB Landfill, BTA and CDA which would minimize migration of organic and inorganic contaminants in groundwater - Clean stormwater from these capped areas can be directed off-site under the site's General NPDES permit.	**GOOD** - Because it is widely implemented at the site. - Some technical challenges with capping on steep slopes. Some of the steeper slopes especially in the CDA will be reduced with large volume of cut/fill grading before cap construction.	**MODERATE TO HIGH** - Borrow soil from off-site NW Borrow Area for cap construction is assumed	**MODERATE** - Green and sustainability impacts are based on cut/fill grading of 250,000 cy and borrow soil/compaction for caps of 200,000 cy, - Materials manufacture, transport, installation (28 acres HDPE, GCL liner, Biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - Because it can achieve the remedial objectives and has been implemented in the adjacent Capped Landfills Area.
5	**Excavate (BTA, CDA remedial areas) (5') + RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - Excavating the contaminants in shallow soils (0-5' bgs) and installing a RCRA-equivalent mono cap will address the potential exposures to ecological receptors - Prevent rainwater infiltration through the PCB Landfill, minimize infiltration through BTA and CDA and clean stormwater from these capped areas can be directed off-site under the site's General NPDES permit. - Minor potential for emissions via dust during soil loading and off-site transport.	**MODERATE TO GOOD** - Minor technical challenges with and uncertainties with the excavation extent and VOC-impacted soil handling especially within the CDA. - Limitations with on-site disposal at PCB Landfill would require off-site transportation and disposal.	**HIGH** - Assume a portion of the excavated soils are transported and disposed off-site at a permitted landfill due to limited capacity at the PCB Landfill.	**MODERATE TO HIGH** - Green and sustainability impacts are based on excavation of 65,000 cy, cut/fill grading of 130,000 cy and borrow soil/compaction for caps of 300,000 cy, - Materials manufacture, transport, installation (4.4 acres HDPE, GCL liner, Biotic barrier) off-site transport and disposal of soil for 65,000 cy. - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**NOT RETAINED** - Because costs are high with off-site disposal costs and does not include the benefits of waste removal in the BTA and associated groundwater protection.

TABLE 10-2
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 1 - PCB LANDFILL, BURIAL TRENCH AREA, CENTRAL DRAINAGE AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
6	**Excavate (Entire BTA (20') + Excavate (CDA remedial area)(5') + RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Dispose Excavated Soil Off-site +Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - Excavating the contaminants in shallow soils and removing wastes in trenches at the BTA, installing a RCRA-equivalent mono cap will address the potential exposures to ecological receptors - Minimize rainwater infiltration through the PCB Landfill, BTA and CDA and clean stormwater from these capped areas can be directed off-site under the site's General NPDES permit. - Waste removal at BTA is a significant benefit but will be transferred to off-site landfill and on-site PCB Landfill. - Short term effectiveness concerns with potential for emissions of contaminants as VOCs and dust during soil loading and off-site transport.	**MODERATE** - Limitations on storage capacity in PCB landfill for this large excavation would require off-site disposal. - Moderate technical challenges with deep excavation, challenges with working in sloped areas and excavating in an area that has numerous groundwater monitoring wells. - Moderate technical challenges with handling VOC emissions from excavation, transportation to off-site location for highly impacted soils	**HIGH** - Assume a portion of the excavated soils are transported and disposed off-site at a permitted landfill due to limited capacity at the PCB Landfill.	**HIGH** - Green and sustainability impacts are based on excavation of 230,000 cy, cut/fill grading of 130,000 cy and borrow soil/compaction for caps of 350,000 cy - Materials manufacture, transport, installation (4.4 acres HDPE, GCL liner, Biotic barrier), off-site transport and disposal of soil for 110,000 cy - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - Though it is high in cost, this alternative is retained as a high contaminant mass removal option with the excavation of the BTA to remove waste in trenches.

NOTES

1. This table presents a screening level analysis of remedial alternatives to address the RAOs discussed in Section 8.
2. This FS Area includes the PCB Landfill, Burial Trench Area and the Central Drainage Area that cover a total of 28.8 acres. The Capped Landfills Area is included in FS Area 1 but no active remedial alternatives are evaluated for it.
3. Effectiveness and implementability are given ratings ranging from poor, poor to moderate, moderate, moderate to good or good.
4. Cost criterion and the green impacts assessment are given a rating of low, low to moderate, moderate, moderate to high, or high.
5. Monitoring for each alternative includes periodic inspection, maintenance and repair of the caps or stormwater controls for the long term.
6. Green impacts assessment is a qualitative rating based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative.

TABLE 10-3
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 2 - RCRA CANYON AND WCSA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
1	**No Action**	**POOR** - Because the potential for exposures to metals for ecological receptors would continue to be present.	**NOT APPLICABLE**	**NONE**	**NONE**	**RETAINED** - Because it is required by the NCP
2	**Ecological-Cap (Westslope RCRA Canyon, WCSA Remedial Area)(2') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**MODERATE** - Soil cap with a 2' vegetative layer will reduce potential exposure and adequately protect ecological receptors. - However, rainwater infiltration would not be reduced significantly and would not provide adequate certainty that groundwater seeps would not pose a concern to stormwater quality and ecological receptors - No soil cover on uncapped areas but grading/BMPs would help stormwater quality.	**MODERATE** - Moderate technical challenges with constructability on the steep slopes present in this area. Long term maintenance challenges with ecological-cap on slopes.	**MODERATE TO HIGH** - Cost for a larger evaporation pond is included	**MODERATE** - Green and sustainability impacts based on cut/fill grading of 130,000 cy, borrow soil and compaction of 49,000 cy, - Construction of larger evaporation pond (+ 9 acres), - Materials (jute mesh, TRMs) manufacturing and installation, grading/BMPs for 19 acres	**RETAINED** - Technology is considered for detailed evaluation.
3	**RCRA-Equivalent Mono Soil Cap (Westslope RCRA Canyon)(5') + Excavation (WCSA Remedial Area) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - RCRA-equivalent soil cap and excavation would protect ecological receptors - Cap would minimize infiltration on the west slope. Potential for groundwater seeps and impacts to stormwater quality would be significantly reduced. - Excavation of impacted soil in WCSA will reduce soil contamination mass and provide fill soil for closing Pond A-5. - Grading and BMPs for uncapped areas would help stormwater quality. Segregated uncapped stormwater flow could be sent off-site based on water quality testing results.	**MODERATE TO GOOD** - Some technical challenges with cap construction and excavation in areas with steep slopes.	**MODERATE TO HIGH** - Cost for a larger evaporation pond is included	**MODERATE** - Green and sustainability impacts based on cut/fill grading of 100,000 cy, excavation of 44,000 cy, borrow soil and compaction of 123,000 cy, - Construction of larger evaporation pond (+ 3 acres), - Materials (jute mesh, TRMs) manufacturing and installation, grading/BMPs for 19 acres	**RETAINED** - Technology is considered for detailed evaluation.
4	**RCRA- Equivalent Mono Soil Cap (Westslope RCRA Canyon, WCSA Remedial Area) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - RCRA-equivalent soil cap would protect ecological receptors - Cap would minimize infiltration on the west slope and WCSA remedial area and decrease overall infiltration. Potential for groundwater seeps and impacts to stormwater quality would be significantly reduced. - Grading and BMPs for uncapped areas would help stormwater quality. - Segregated uncapped stormwater flow could be sent off-site based on water quality testing results.	**MODERATE TO GOOD** - Technical challenges with excavation in areas with steep slopes.	**MODERATE TO HIGH** - Cost for a larger evaporation pond is included	**MODERATE** - Green and sustainability impacts based on cut/fill grading of 130,000 cy, borrow soil and compaction of 123,000 cy, - Construction of larger evaporation pond (+ 3 acres), - Materials (jute mesh, TRMs) manufacturing and installation, grading/BMPs for 19 acres	**RETAINED** - Technology is considered for detailed evaluation.
5	**RCRA- Equivalent Mono Soil Cap (Westslope RCRA Canyon) (5') + Excavation (WCSA Remedial Area) (5') + Clean Soil Cover (Uncapped Area)(2') + Stormwater Controls (Segregate Capped and Uncapped Area SW) + ICs + Monitoring**	**MODERATE TO GOOD** - RCRA-equivalent soil cap would protect ecological receptors and - Minimize infiltration on the west slope. Potential for groundwater seeps and impacts to stormwater quality would be significantly reduced. - Excavation of impacted soil in WCSA will reduce soil contamination mass and provide fill soil for closing Pond A-5. - The soil cover across the entire uncapped area would ensure that the stormwater quality meets the site's General NPDES permit requirements for off-site discharge.	**MODERATE** - Technical challenges with compacting soil cover and excavation in steep areas with in the east slope of the canyon	**MODERATE TO HIGH** - No need for larger evaporation pond	**MODERATE TO HIGH** - Green and sustainability impacts based on cut/fill grading of 400,000 cy, excavation of 44,000 cy, and borrow soil and compaction of 210,000 cy, - Materials (jute, TRMs) manufacturing and installation for steep portion of east slope (7 acres). - No need for larger evaporation pond.	**RETAINED** - Technology is considered for detailed evaluation.

TABLE 10-3
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 2 - RCRA CANYON AND WCSA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
6	**RCRA- Equivalent Hybrid Cap (Westslope RCRA Canyon)(5') + Excavation (WCSA Remedial Area)(5') + Clean Soil Cover (Uncapped Areas)(2') + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - RCRA-equivalent hybrid cap and excavation would protect ecological receptors - Minimize infiltration on the west slope and WCSA remedial area. Potential for groundwater seeps and impacts to stormwater quality would be significantly reduced. - Grading and BMPs for uncapped areas would help stormwater quality. - Segregated uncapped stormwater flow could be sent off-site based on water quality testing results.	**MODERATE** - Technical challenges with cap construction in areas with steep slopes. Potential for slip failure exists though it is less likely than with the composite geomembrane/GCL with the RCRA cap.	**MODERATE TO HIGH** - No need for larger evaporation pond	**MODERATE TO HIGH** - Green and sustainability impacts based on cut/fill grading of 400,000 cy, excavation of 44,000 cy, borrow soil and compaction of 49,000 cy, - Construction of larger evaporation pond (+ 3 acres), - Materials (HDPE liner, geocomposite drainage layer, biotic barrier) for 13.9 acres, (jute mesh, TRMs) manufacturing and installation for 19 acres	**RETAINED** - Technology is considered for detailed evaluation.
7	**Evapotranspirative (ET) Cap (Westslope RCRA Canyon)(5') + Excavation (WCSA Remedial Area)(5') + Clean Soil Cover (Uncapped Areas)(2') + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - ET cap would protect ecological receptors - ET cap would minimize infiltration on the west slope. Potential for groundwater seeps and impacts to stormwater quality would be significantly reduced. - Excavation of impacted soil in WCSA will reduce soil contamination mass and provide fill soil for closing Pond A-5. - The soil cover across the entire uncapped area would ensure that the stormwater quality meets the site's General NPDES permit requirements for off-site discharge.	**MODERATE** - Technical challenges with compacting soil cover and excavation in areas with steep slopes especially in east slope of canyon.	**MODERATE TO HIGH** - No need for larger evaporation pond	**MODERATE TO HIGH** - Green and sustainability impacts based on cut/fill grading of 400,000 cy, excavation of 44,000 cy, and borrow soil and compaction of 210,000 cy, - Materials (jute, TRMs) manufacturing and installation for steep portion of east slope (7 acres). - No need for larger evaporation pond.	**RETAINED** - Technology is considered for detailed evaluation.
8	**RCRA- Equivalent Hybrid Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring**	**GOOD** - RCRA equivalent hybrid cap will adequately protect ecological receptors and achieve risk based goals for this FS Area. - Will eliminate surface water infiltration and potential for seeps impacting stormwater quality. - The capping of the entire canyon would ensure that the stormwater quality meets the site's General NPDES permit requirements for off-site discharge.	**MODERATE** - Significant technical challenges with RCRA hybrid cap construction in areas with very steep slopes in the east slope of the canyon.	**HIGH** - Includes RCRA hybrid cap for entire RCRA Canyon and WCSA	**HIGH** - Green and sustainability impacts based on cut/fill grading of 400,000 cy, borrow soil and compaction of 120,000 cy - Materials (HDPE liner, geocomposite drainage layer, GCL, biotic barrier) for 33 acres - No need for larger evaporation pond.	**RETAINED** - Though it is high in cost and has challenges with implementation due to steep slopes it is better suited for steep slopes than the conventional RCRA cap.
9	**Evapotranspirative (ET) Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring**	**GOOD** - RCRA cap will adequately protect ecological receptors and achieve risk based goals for this FS Area. - Will eliminate surface water infiltration throughout the RCRA Canyon and potential for seeps - The capping of the entire canyon would ensure that the stormwater quality meets the site's General NPDES permit requirements for off-site discharge.	**MODERATE** - Moderate technical challenges with ET cap construction in areas with very steep slopes in the east slope of the canyon. - Slope stability is considered better for a soil cap than a cap with a geosynthetic liner.	**HIGH** - Includes ET cap for entire RCRA Canyon and WCSA	**HIGH** - Green and sustainability impacts based on cut/fill grading of 400,000 cy, borrow soil and compaction of 300,000 cy, - Amendments for 4-foot thick vegetative layer - No need for larger evaporation pond.	**RETAINED** - Though it is high in cost and has challenges with implementation due to steep slopes it is better suited for steep slopes than the conventional RCRA cap.
10	**RCRA Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring**	**GOOD** - RCRA cap will adequately protect ecological receptors and achieve risk based goals for this FS Area. - Will eliminate potential surface water infiltration and potential for seeps - The capping of the entire canyon would ensure that the stormwater quality meets the site's General NPDES permit requirements for off-site discharge.	**POOR TO MODERATE** - Technical challenges with RCRA cap construction in areas with steep slopes. Even with large cut/fill grading volumes, side slopes will be 2:1. - Potential for slip failure at the geomembrane interface	**HIGH** - Includes highest cost RCRA cap for entire RCRA Canyon and WCSA	**HIGH** - Green and sustainability impacts based on cut/fill grading of 400,000 cy, borrow soil and compaction of 240,000 cy, - Materials (HDPE liner, geocomposite drainage layer, GCL, biotic barrier) for 33 acres. - No need for larger evaporation pond.	**NOT RETAINED** - Because a RCRA cap is very high in cost and has significant challenges with implementation due to steep slopes. Potential for slip failure of the vegetative layer over the HDPE on steep slopes even after cut/fill grading expected to be 2:1 max.

TABLE 10-3
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 2 - RCRA CANYON AND WCSA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

NOTES

1. This table presents a screening level analysis of remedial alternatives to address the RAOs discussed in Section 8.
2. This FS Area includes RCRA Canyon and the West Canyon Spray Area that covers a total of 36 acres.
3. Effectiveness and implementability are given ratings ranging from poor, poor to moderate, moderate, moderate to good or good.
4. Cost criterion and the green impacts assessment are given a rating of low, low to moderate, moderate, moderate to high, or high.
5. Monitoring component of each alternative includes inspection, maintenance and repair of caps and stormwater controls.
6. Green impacts assessment is a qualitative rating based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative.

TABLE 10-4
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 3 - FORMER PONDS AND PADS, REMAINING ON-SITE AREAS, LTA, MSA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
1	**No Action**	**POOR** - Will not achieve the area-wide remedial objective.	**NOT APPLICABLE**	**NONE**	**NONE**	**RETAINED** - Because it is required by the NCP
2	**Ecological -cap (Locations 2, 3, 4) (2') + Asphalt Cap (Location 1) + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring** .	**MODERATE** - Capping the shallow soils with an ecological -cap and asphalt will adequately protect ecological and human receptors. - The ecological -cap allows moderate infiltration hence this alternative does not protect groundwater adequately. - With the ecological -cap, it is not certain that the stormwater quality discharge from Area 3 would be allowable for off-site discharge under the site's General permit.	**MODERATE** - No significant challenges with construction of ecological -caps anticipated and an asphalt cap already exists. However, challenges with long term ecological -cap maintenance can be anticipated.	**MODERATE TO HIGH** - Though capital costs are expected to be moderate, O&M costs to maintain ecological -caps are assumed to be moderate to high	**MODERATE** - Green and sustainability impacts are based on cut/fill grading of 60,000 cy and borrow soil/compaction for caps of 24,000 cy - Asphalt cap of 2 acres, materials manufacture, transport, installation (6.6 acres geonet). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**NOT RETAINED** - Because it does not provide adequate protection for groundwater and due to concerns with the ecological -cap not ensuring stormwater quality for off-site discharge and concerns with long term maintenance of ecological -caps.
3	**RCRA Cap (Locations 2, 3, 4) + Excavate/New Asphalt Cap (Location 1)(5') + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**GOOD** - With the RCRA cap, ecological risks are addressed and infiltration is prevented that protects groundwater. - Surface water quality is likely to be improved with the RCRA caps and the Grading/BMPs that would allow stormwater off-site discharge under the site's General permit. - Removal of the impacted soils at Location 1 would remove contaminant mass and protect ecological receptors.	**MODERATE TO GOOD** - No significant challenges with construction of RCRA caps. - Minor challenges with excavation due to the presence of the groundwater treatment equipment and storage tanks present in this area.	**MODERATE TO HIGH** - Capital costs are expected to be higher than Alt 2. - O&M costs are expected to be lower than Alt 2	**MODERATE** - Green and sustainability impacts are based on cut/fill grading of 60,000 cy and borrow soil/compaction for caps of 48,000 cy, excavation of 8,000 cy, materials - Manufacture, transport, installation (6.6 acres HDPE, GCL liner, biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies and helps reduce pond water volume for Area 4 remedy	**RETAINED** - Because it is rated better with respect to effectiveness and implementability and is not very high in cost
4	**RCRA Cap (Location 2) + Excavate ((Location 3)(20'); (Location 4)(5')) + Excavate/New Asphalt Cap (Location 1)(5') + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**GOOD** - With the RCRA cap, ecological risks are addressed and infiltration is prevented that protects groundwater. - Surface water quality is likely to be improved with the RCRA caps and the Grading/BMPs that would allow stormwater off-site discharge under the site's General permit. - Removal of the impacted soils at Location 1 would remove contaminant mass and protect ecological receptors.	**MODERATE TO GOOD** - No significant challenges with construction of RCRA caps. - Minor challenges with excavation due to the presence of the groundwater treatment equipment and storage tanks present in this area.	**MODERATE TO HIGH** - Assumes excavated soils from Location 3 (Ponds A/B) are disposed in on-site PCB Landfill.	**MODERATE** - Green and sustainability impacts are based on cut/fill grading of 17,000 cy, excavation of 92,000 cy and borrow soil/compaction for caps and excavation of 100,000 cy - Materials, manufacture, transport, installation (2.8 acres HDPE, GCL liner, biotic barrier) - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - Because it is rated better with respect to effectiveness and implementability and is not very high in cost
5	**RCRA Cap (Location 2) + Excavate ((Location 3)(20'); (Location 4)(5'); (Location 10)(50'))/Place in PCB Landfill/Backfill + Excavate/New Asphalt Cap (Location 1)(5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**GOOD** - With the RCRA cap, ecological risks are addressed and infiltration is prevented that protects groundwater. - Surface water quality is likely to be improved with the RCRA caps and the Grading/BMPs that would allow stormwater off-site discharge under the site's General permit. - Removal of the impacted soils at Location 1 would remove contaminant mass and protect ecological receptors.	**MODERATE TO GOOD** - No significant challenges with construction of RCRA caps. - Minor challenges with excavation due to the presence of the groundwater treatment equipment and storage tanks present in this area.	**MODERATE TO HIGH** - Assumes excavated soils from Location 3 (Ponds A/B) and Location 10 are disposed in on-site PCB Landfill.	**MODERATE** - Green and sustainability impacts are based on cut/fill grading of 17,000 cy, excavation of 157,000 cy and borrow soil/compaction for caps and excavation of 170,000 cy - Materials manufacture, transport, installation (2.8 acres HDPE, GCL liner, biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - Because it is rated better with respect to effectiveness and implementability and is not very high in cost

TABLE 10-4
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 3 - FORMER PONDS AND PADS, REMAINING ON-SITE AREAS, LTA, MSA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
6	**Excavate (Locations 2, 4) (5'); Location 3(20'))/Off-site Disposal/Backfill + Excavate/Asphalt Cap (Location 1)(5') + In-Situ Thermal Desorption (Location 10) (5'-50' bgs) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**MODERATE** - ISTD is effective for remediation of SVOCs but limitations due to the claystone formation and the difficulty of extraction of soil vapors in the low permeability matrix. - Uneven in-situ heating of the subsurface. - Potential for emissions of low levels of SVOCs into ambient air.	**MODERATE** - Challenges with operation of the in-situ vapor extraction component - Uneven in-situ heating of the subsurface.	**HIGH** - Because of very high energy and labor costs of ISTD at Location 10.	**HIGH** - Green and sustainability impacts are based on excavation of 61,000 cy and 13.1 million KWhr of electricity for ISTD, - Transport 60,000 tons of soils about 120 miles to Buttonwillow. - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**NOT RETAINED** - Because of concerns with the effectiveness and implementability of the in-situ thermal treatment in the low permeability claystone formation and the very high cost.
7	**Excavate ((Locations 2, 4) (5'); (Location 3)(20'); (Location 10) (50'))/Off-site Disposal/Backfill + Excavate/New Asphalt Cap (Location 1)(5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - Effective for PAHs and other SVOCs but limitations due to the claystone soils and the difficulty of extraction of soil vapors in low permeability matrix. - Potential for emissions during excavation of metals, - VOCs at Location 3 and SVOCs in dust at Location 10.	**MODERATE** - Moderate challenges with the deep excavation.	**HIGH** - Because of very high off-site transportation and disposal costs for Location 3 and Location 10.	**HIGH** - Green and sustainability impacts are based on excavation of 200,000 cy and backfill borrow soil/compaction for caps of 220,000 cy, - Transport 190,000 tons of soils about 120 miles to Buttonwillow. - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - Because it addresses contaminant mass removal and effectiveness is better than Alternative 6 though it is very high in cost.

NOTES

1. This table presents a screening level analysis of remedial alternatives to address the RAOs discussed in Section 8.
2. FS Area 3 includes Former Ponds and Pads, Remaining On-site Areas, Roadways, Maintenance Shed Area and Liquids Treatment Area.
3. Effectiveness and implementability are given ratings ranging from poor, poor to moderate, moderate, moderate to good or good.
4. Cost criterion and the green impacts assessment are given a rating of low, low to moderate, moderate, moderate to high, high or very high.
5. Monitoring component of each alternative includes inspection, maintenance and repair of caps and stormwater controls.
6. Green impacts assessment is a qualitative rating based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative.

TABLE 10-5
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 4 - STORMWATER PONDS AND IMPOUNDMENTS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
1	**No Action**	**POOR** - Because the pond water and sediments with COCs will pose a potential risk to ecological receptors. - Impacted sediments will affect stormwater runoff quality and will not meet General NPDES benchmarks - Impacted sediments may serve as a continuing source to groundwater contamination	**NOT APPLICABLE**	**NONE**	**NONE**	**RETAINED** - Because it is required by CERCLA
2	**Ecological-Cap (RCF, A-Series Pond) (2') + Construct New 11-Acre Evaporation Pond North of RCF Pond + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**MODERATE** - Controls potential for long term exposure to contaminants for ecological receptors. - RCF and A-Series Pond bottoms are raised to above the future anticipated water table and thus avoid groundwater intrusion (seeps) into the former pond footprint. - Limitations on protection of ecological species with large 11-acre evaporation pond - Infiltration of surface water into groundwater would occur with the 2-foot thick ecological-cap at the RCF and the A-Series Pond. - Surface water infiltration will be eliminated in Pond 18 with the RCRA cap and Ponds A-5 and 13 which are lined stormwater retention basins.	**MODERATE** - Moderate technical challenges with construction of new 11-acre evaporation pond with netting and drift fences to protect ecological receptors - Minor challenges with the ecological-cap construction but some long term maintenance concerns with ecological-caps.	**HIGH** - Includes construction of a new 11-acre evaporation pond north of the RCF Pond - Borrow soil from off-site NW Borrow Area for cap construction is assumed.	**HIGH** - Green and sustainability impacts are based on cut/fill grading or excavation of 120,000 cy and borrow soil/compaction for caps of 300,000 cy, - Materials manufacture, transport, installation (54 acres HDPE, GCL liner, 2.8 acres Biotic barrier). -Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - This alternative is retained as an example of ecological-caps with a new 11-acre evaporation pond north of RCF.
3	**Ecological-Cap (RCF Pond, Segregate East RCF)(2') + Construct 11-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**MODERATE** - Controls potential for long term exposure to contaminants for ecological receptors. - RCF West and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion (seeps) into the former pond footprint. - Segregated RCF East serves as a contingency plan if groundwater rises unexpectedly. Potential for surface water impacts from groundwater intrusion is minimized. - Limitations on protection of ecological species with large 11-acre evaporation pond - Surface water infiltration would occur in the RCF Pond but is expected to be reduced because stormwater is directed by the sheet flow over the sloped cap and drains off-site. - Surface water infiltration will be eliminated in the A-Series Pond, Pond 18 and Ponds A-5 and 13 which are lined or have a RCRA cap.	**MODERATE** - Moderate technical challenges with constructing 11-acre evaporation pond with netting and drift fences to protect ecological species. - Minor challenges with the ecological-cap construction but some long term maintenance concerns with ecological-caps.	**MODERATE TO HIGH** - Borrow soil from off-site NW Borrow Area for cap construction is assumed.	**MODERATE TO HIGH** - Green and sustainability impacts are based on cut/fill grading or excavation of 43,000 cy and borrow soil/compaction for caps of 175,000 cy - Materials manufacture, transport, installation (54 acres HDPE, GCL liner, 2.8 acres Biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - Clean fill required for raising pond bottom or cap construction would be borrowed from on-site sources or the off-site NW Borrow Area.

TABLE 10-5
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 4 - STORMWATER PONDS AND IMPOUNDMENTS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

4	**Ecological-Cap (RCF Pond)(2') + Construct 11-Acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**MODERATE** - Controls potential for long term exposure to contaminants for ecological receptors. - RCF and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion (seeps) into the former pond footprint. - Limitations on protection of ecological species with large 11-acre evaporation pond - Surface water infiltration would occur in the RCF Pond but is expected to be reduced because stormwater is directed by the sheet flow over the sloped cap and drains off-site. - Surface water infiltration will be eliminated in the A-Series Pond, Pond 18 and Ponds A-5 and 13 which are lined or have a RCRA cap.	**MODERATE** - Moderate technical challenges with constructing 11-acre evaporation pond with netting and drift fences to protect ecological species. - Minor technical challenges in constructing ecological-cap. Some long term maintenance concerns with ecological-caps.	**MODERATE TO HIGH** - Borrow soil from off-site NW Borrow Area for cap construction is assumed.	**MODERATE TO HIGH** - Green and sustainability impacts are based on cut/fill grading or excavation of 56,000 cy and borrow soil/compaction for caps of 205,000 cy - Materials manufacture, transport, installation (54 acres total HDPE, GCL liner, 2.8 acres Biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - The capped surfaces are sloped to allow appropriate drainage of stormwater and any clean fill required for this this would be borrowed from on-site sources or off-site NW Borrow Area.
5	**Ecological-Cap (RCF Pond, Portion of A-Series Pond) + Construct 6-Acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - Controls potential for long term exposure to contaminants for ecological receptors. - RCF and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion (seeps) into the former pond footprint. - Surface water infiltration would occur in the RCF Pond but is expected to be reduced because stormwater is directed by the sheet flow over the sloped cap and drains off-site via retention basin in Pond 13. - Surface water infiltration will be eliminated in the A-Series Pond, Pond 18 and Ponds A-5 and 13 which are lined or have a RCRA cap.	**MODERATE TO GOOD** - Less technical challenges with constructing six 1-acre evaporation ponds with netting and drift fences to protect ecological species compared to 11-acre pond. - Minor technical challenges in constructing ecological-cap. Some long term maintenance concerns with ecological-caps.	**MODERATE** - Borrow soil from off-site NW Borrow Area for cap construction is assumed. - Lower cost for a smaller 6-acre evaporation pond	**MODERATE** - Green and sustainability impacts are based on cut/fill grading or excavation of 56,000 cy and borrow soil/compaction for caps of 155,000 cy - Materials manufacture, transport, installation (32 acres HDPE, GCL liner, 2.8 acres Biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - The capped surfaces are sloped to allow appropriate drainage of stormwater and any clean fill required for this this would be borrowed from on-site sources or off-site NW Borrow Area.
6	**Ecological-Cap (RCF Pond, A-Series Pond)(2') + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring** [No Evaporation Pond]	**MODERATE TO GOOD** - Controls potential for long term exposure to contaminants for ecological receptors. - RCF and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion (seeps) into the former pond footprint. - Surface water infiltration would occur in the RCF and A-Series Pond but is expected to be reduced because stormwater is directed by the sheet flow over the sloped cap and drains off-site. - Surface water infiltration will be eliminated in Pond 18 and Ponds A-5 and 13 which are HDPE lined or have a RCRA cap.	**MODERATE TO GOOD** - Minor technical challenges in constructing ecological-cap. - Some long term maintenance concerns with ecological-caps.	**MODERATE** - All ponds are closed. No cost for evaporation pond construction - Borrow soil from off-site NW Borrow Area for cap construction is assumed.	**MODERATE** - Green and sustainability impacts are based on cut/fill grading or excavation of 56,000 cy and borrow soil/compaction for caps of 175,000 cy - Materials manufacture, transport, installation (13 acres HDPE, GCL liner, 2.8 acres Biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - This alternative is retained as an example of pond closures in Area 4 without a future on-site evaporation pond. - This alternative is intended to match Area 5 groundwater alternatives that involve on-site treatment of inorganics in the LTP for off-site discharge to Casmalia Creek.
7	**ET Cap (RCF Pond, Portion of A-Series Pond) + Construct 6-Acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - Controls potential for long term exposure to contaminants for ecological receptors. - RCF and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion (seeps) into the former pond footprint. - Surface water infiltration would occur in the RCF Pond but is expected to be reduced because stormwater is directed by the sheet flow over the sloped cap and drains off-site. - Surface water infiltration will be eliminated in the A-Series Pond, Pond 18 and Ponds A-5 and 13 which are lined or have a RCRA cap.	**MODERATE TO GOOD** - Less technical challenges with constructing six 1-acre evaporation ponds with netting and drift fences to protect ecological species compared to 11-acre pond. - Minor technical challenges in constructing ET cap.	**MODERATE TO HIGH** - Vegetative layer soils will require amendments for effective plant growth - Borrow soil from off-site NW Borrow Area for cap construction is assumed.	**MODERATE TO HIGH** - Green and sustainability impacts are based on cut/fill grading or excavation of 150,000 cy and borrow soil/compaction for caps of 200,000 cy - Materials manufacture, transport, installation (40 acres HDPE, GCL liner, 2.8 acres Biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - The capped surfaces are sloped to allow appropriate drainage of stormwater and any clean fill required for this this would be borrowed from on-site sources or off-site NW Borrow Area.

TABLE 10-5
SCREENING OF REMEDIAL ALTERNATIVES FOR FS AREA 4 - STORMWATER PONDS AND IMPOUNDMENTS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

8	**Excavate (RCF Pond, A-Series Pond) (5') + Construct New 11-Acre Lined Evaporation Pond (North of RCF Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**MODERATE** - Excavates sediments and backfills with clean soil cover and controls potential for long term exposure to contaminants for ecological receptors. - Potential concerns with metals/other contaminant emissions through dust from excavation - RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion (seeps) into the former pond footprint. - Limitations on protection of ecological species with large 11-acre evaporation pond - Infiltration of surface water into groundwater would occur. Rainwater infiltration will be reduced with the sloped cap on the bottom of the ponds.	**MODERATE** - Moderate technical challenges with excavation of the pond bottoms and backfill compaction. - Difficulties with excavation equipment in muddy pond bottoms. - Moderate technical challenges with constructing 11-acre evaporation pond with netting and drift fences to protect ecological species.	**HIGH** - Includes cost for construction of new evaporation pond north of RCF Pond. - Borrow soil from off-site NW Borrow Area for cap construction or fill is assumed.	**HIGH** - Green and sustainability impacts are based on excavation of 170,000 cy and backfill borrow soil/compaction for caps of 200,000 cy - Transport 140,000 tons of soils about 120 miles to Buttonwillow, - Materials manufacture, transport, installation (54 acres HDPE, GCL liner, 2.8 acres Biotic barrier). Assume use of on-site water in ponds minimizes use of other clean water supplies.	**RETAINED** - This alternative is retained as an example of an aggressive excavation alternative that removes waste as opposed to capping with other alternatives.
9	**RCRA Cap (RCF Pond) + Construct New 11-Acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**MODERATE TO GOOD** - A RCRA cap over the RCF and lined A-Series Ponds controls potential for long term exposure to contaminants for ecological receptors. - RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion (seeps) into the former pond footprint. - Limitations on protection of ecological species with large 11-acre evaporation pond - Infiltration of surface water into groundwater would not occur because of the low permeability of the RCRA cap. All surface water on the RCF and A-Series Ponds are directed through drains for off-site discharge. - Surface water infiltration will be eliminated in Pond 18 with the RCRA cap and Ponds A-5 and 13 which are lined stormwater retention basins.	**MODERATE** - Moderate technical challenges with constructing 11-acre evaporation pond with netting and drift fences to protect ecological species. - Minor technical challenges with capping deepest part of pond bottoms and steep side slopes of the RCF and A-Series Ponds.	**HIGH** - Borrow soil from off-site NW Borrow Area for cap construction is assumed.	**HIGH** - Green and sustainability impacts are based on cut/fill grading of 43,000 cy and borrow soil/compaction for caps of 230,000 cy, - Some pre-processing of soils prior to placement and compaction, - Materials manufacture, transport, installation (54 acres HDPE, GCL liner, 11 acres Biotic barrier). - Assume use of on-site water in ponds minimizes use of other clean water supplies.	**NOT RETAINED** - Because it is very high in cost and not cost effective given complete prevention of infiltration through pond sediments is not a specific objective. Significant reduction of infiltration is achieved by lower cost cap options such as ecological-cap with sloped surface drains as shown by the HELP model results.

NOTES

1. This table presents a screening level analysis of remedial alternatives for the closure of stormwater ponds and impoundments including the RCF Pond, A-Series Pond, Pond A-5, Pond 18 and Pond 13.
2. The new evaporation pond component is intended for treated PSCT groundwater and the PCT groundwater as part of the Area 5 groundwater remedy and is expected to be either 6 or 11 acres. One alternative without an evaporation pond is included.
3. Effectiveness and implementability are given ratings ranging from poor, poor to moderate, moderate, moderate to good or good.
4. Cost criterion and the green impacts assessment are given a rating of low, low to moderate, moderate, moderate to high, high or very high.
5. Monitoring component of each alternative includes inspection, maintenance and repair of caps and stormwater controls.
6. Green impacts assessment is a qualitative rating based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative.

TABLE 10-6A
SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER FS AREA 5 NORTH
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
1	**No Action**	**POOR** - Aquifer restoration will take hundreds of years by dissolution, precipitation and other attenuation processes for inorganic contaminants. - No long term monitoring is included to document the attenuation.	**NOT APPLICABLE**	**NONE**	**NONE**	**RETAINED** **-** Because it is required by the NCP
2	**Extraction (PSCT, Gallery Well) + Treat and Discharge PSCT Groundwater to On-site Evaporation Pond + ICs + Monitoring**	**POOR TO MODERATE** **-** Would address the objective of containing or controlling on-site sources but does not directly address free phase NAPL in the southern P/S Landfill. - COC mass reduction is minimal and aquifer restoration would take hundreds of years.	**GOOD** **-** Because this alternative is already operating currently. No significant challenges are expected. - The total extracted PSCT flows are expected to decrease with the increase in the total capping of FS Area 1 (and reduced infiltration) expected as part of the site remedy.	**MODERATE** **-** Primarily long term O&M costs for PSCT and Gallery Well extraction	**LOW TO MODERATE** **-** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -GWTS treatment of PSCT groundwater. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS. -Emissions and fuel use during transport and off-site disposal of Gallery Well liquids.	**RETAINED** - Though it does not actively address the NAPL by extraction, it is effective at containing dissolved contaminants from migrating south of the PSCT.
3	**Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 New LHSU wells) + Treat and Discharge PSCT Groundwater to On-site Evaporation Pond + ICs + Monitoring**	**MODERATE TO GOOD** **-** Would address the objective of containing or controlling on-site sources, address NAPL source to the extent practicable, and support the proposed TI waiver in Area 5 North. - Would effectively contain or control free phase NAPL source by NAPL-only extraction at the southern P/S Landfill and limited NAPL extraction in the CDA. - Effective at controlling migration of dissolved phase COCs primarily VOCs and metals out of Area 5 North. - COC mass reduction is modest and aquifer restoration would take hundreds of years.	**MODERATE TO GOOD** **-** Because this alternative is already operating currently. - Moderate challenges can be expected with well installation of up to 16 wells in the P/S Landfill. - The total extracted PSCT flows are expected to decrease with the anticipated additional capping remedies expected for FS Area 1.	**MODERATE TO HIGH** **-** Includes Capital and O&M costs for NAPL-only extraction, PSCT and Gallery Well extraction	**MODERATE** **-** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: - PSCT and Gallery Well extraction - GWTS treatment of PSCT groundwater. - Includes consumption of materials such as LPGAC and VPGAC associated with the GWTS. - NAPL-only extraction would have a relatively small footprint increase due to periodic operation of these skimmer pumps. - Emissions during transport and off-site disposal of Gallery Well and NAPL-only extraction liquids.	**RETAINED** **-** Because it would address the objective of containing or controlling on-site sources, reduce the NAPL source and support the proposed TI waiver.
4	**Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 New LHSU wells) + Treat and Discharge PSCT Groundwater Off-site (No Evaporation Pond) + ICs + Monitoring**	**MODERATE TO GOOD** **-** Would address the objective of containing or controlling on-site sources, address DNAPL source to the extent practicable, and support the proposed TI waiver in Area 5 North. - Would effectively contain or control free phase DNAPL source by periodic DNAPL-only extraction at the southern P/S Landfill and limited NAPL extraction in the CDA - Effective at controlling migration of dissolved phase COCs primarily VOCs and metals. - COC mass reduction is modest and aquifer restoration would take hundreds of years. - Waste brine is generated by reverse osmosis that would require off-site disposal	**MODERATE** - Moderate challenges can be expected with well installation of up to 16 wells in the P/S Landfill. - The total extracted PSCT flows are expected to decrease with the anticipated additional capping remedies expected for FS Area 1. - Challenges with off-site discharge RO treatment and NPDES permit challenges with requirement of Basin Plan exemption	**HIGH** **-** Includes Capital and O&M costs for NAPL-only extraction, PSCT and Gallery Well extraction - Includes reverse osmosis treatment and brine disposal cost	**MODERATE TO HIGH** **-** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: - PSCT and Gallery Well extraction - GWTS treatment of PSCT groundwater. - Includes consumption of materials such as LPGAC and VPGAC associated with the GWTS. - NAPL-only extraction would have a relatively small footprint increase due to periodic operation of these skimmer pumps. - Emissions during transport and off-site disposal of Gallery Well and DNAPL-only liquids.	**RETAINED** **-** Because it would address the objective of containing or controlling on-site sources, reduce the NAPL source and support the proposed TI waiver.

TABLE 10-6A
SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER FS AREA 5 NORTH
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
5	**Extraction (PSCT, Gallery Well) + Extraction (Aggressive, 16 Large NAPL wells) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 New LHSU wells) + Treat and Discharge to On-site Evaporation Pond + ICs + Monitoring**	**MODERATE TO GOOD** - Would address the objective of containing or controlling on-site sources and address DNAPL source by continuous extraction. - Effective at controlling migration of dissolved phase COCs primarily VOCs and metals. - COC mass reduction is modest compared to total mass of contaminants in groundwater and aquifer restoration would still take hundreds of years. - Potential concerns with emissions during leachate treatment system malfunction.	**MODERATE** - Challenges expected with large diameter well installation inside the P/S Landfill. - Uncertainties with the performance of the on-site leachate treatment plant to adequately treat extremely high contaminant levels. - Would need a larger evaporation pond on-site than Alternative 4 with the additional 5.6 million gallons of treated groundwater.	**HIGH** - Because it includes the long term O&M cost of operation of the 10 gpm on-site leachate treatment system. Flow rates will decrease with time as the P/S Landfill is dewatered.	**HIGH** - Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: - PSCT and Gallery Well extraction -16 NAPL well extraction -GWTS treatment of PSCT groundwater and consumption of materials such as LPGAC and VPGAC - Leachate treatment of 5.2 million gallons per year using air stripping and LPGAC technology including electricity for transfer pumps, aeration blowers and LPGAC for polishing and VPGAC for vapor treatment. -Emissions during transport and off-site disposal of Gallery Well and NAPL-only liquids. -The addition of aggressive NAPL extraction would result in significant increase in energy use/GHG emissions due to continuous operation of extraction pumps and leachate treatment system.	**RETAINED** - Because it achieves control and containment of contaminants and as an example of an aggressive alternative for NAPL source reduction for detailed analysis
6	**Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 New LHSU wells) + Treat and Discharge to On-site Evaporation Pond + ICs + Monitoring**	**MODERATE TO GOOD** - Would address the objective of containing or controlling on-site sources and address NAPL source by dewatering the P/S Landfill. - Effective at controlling migration of dissolved phase COCs primarily VOCs and metals. - COC mass reduction is modest compared to total mass of contaminants in groundwater and aquifer restoration would still take hundreds of years. - Significant risk of release of leachate liquids during drilling into bottom of landfill - Significant risk of release of liquids from drums being punctured during drilling	**POOR TO MODERATE** - Significant technical challenges with horizontal well installation that would involve drilling under the clay barrier into the P/S Landfill - concerns with drill bit veering due to metallic drums in landfill waste - very difficult to track the LHSU contact across the entire length of the well	**HIGH** - Because it includes the high cost of off-site disposal of liquids. Flow rates will decrease with time as the P/S Landfill is dewatered.	**HIGH** - Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: - PSCT and Gallery Well extraction -5 horizontal well extraction -GWTS treatment of PSCT groundwater and consumption of materials such as LPGAC and VPGAC -Emissions during transport and off-site disposal of Gallery Well and dewater landfill liquids. -The addition of aggressive NAPL liquids extraction is a potential risk to the environment	**RETAINED** - Because it achieves control and containment of contaminants and as an example of an aggressive alternative for NAPL source reduction for detailed analysis.
7	**Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells) + Extraction (NAPL-only in CDA, 12 new wells) + Extraction (4 New LHSU wells) + Monitoring (8 New LHSU wells) + Treat and Discharge Off-site + ICs + Monitoring**	**MODERATE TO GOOD** - Would address the objective of containing or controlling on-site sources and address NAPL source by dewatering the P/S Landfill. - Effective at controlling migration of dissolved phase COCs primarily VOCs and metals. - COC mass reduction is modest compared to total mass of contaminants in groundwater and aquifer restoration would still take hundreds of years. - Significant risk of release of leachate liquids during drilling into bottom of landfill - Significant risk of release of liquids from drums being punctured during drilling - Large amount of waste brine liquids will be generated that will require off-site disposal	**POOR TO MODERATE** - Significant technical challenges with horizontal well installation that would involve drilling through the clay barrier into the P/S Landfill - concerns with drill bit veering due to metallic drums in landfill waste - very difficult to track the LHSU contact across the entire length of the well - Off-site discharge RO treatment and NPDES permit challenges with requirement of Basin Plan exemption	**HIGH** - Because it includes the high cost of off-site disposal of liquids. Flow rates will decrease with time as the P/S Landfill is dewatered.	**HIGH** - Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: - PSCT and Gallery Well extraction - 5 horizontal wells extraction -GWTS treatment of PSCT groundwater and consumption of materials such as LPGAC and VPGAC -Emissions during transport and off-site disposal of Gallery Well, dewater liquids and brine disposal -The addition of aggressive NAPL liquids extraction is a potential risk to the environment	**RETAINED** - Because it achieves control and containment of contaminants and as an example of an aggressive alternative for NAPL source reduction for detailed analysis.

TABLE 10-6A
SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER FS AREA 5 NORTH
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
8	**Aggressive Extraction (50 New Extraction Wells) + Extraction (Aggressive, 16 Large NAPL Wells) + Extraction (PSCT, Gallery Well) + Treat and Discharge Off-site + ICs + Monitoring**	**MODERATE TO GOOD** **-** Will pump and treat a large volume of groundwater over a long period of time. But the fractured bedrock conditions would pose a challenge due to VOCs diffused into the bedrock matrix that would slowly diffuse out during extraction. Even if the NAPL and dissolved VOCs are significantly reduced, VOCs will continue to diffuse out of the rock matrix over hundreds of years (refer Appendix A for timeframe calculation). - Radius of influence of wells would be limited by the bedrock conditions. - Potential air emissions from the treatment system would be a concern. - Large amounts of waste (e.g. brine from RO) would be generated that would need to be disposed off-site - Concentrations will decrease over decades of operation but will not restore site groundwater to MCLs. - Aquifer restoration will still take hundreds of years and not significantly different from previous alternatives.	**POOR TO MODERATE** - Technical challenges with capturing groundwater from the extraction wells in this bedrock formation can be expected. - Significant well clogging can be anticipated due to high TDS. - Water treatment can pose a challenge with high TDS and metals in meeting NPDES discharge standards. - Off-site discharge RO treatment and NPDES permit challenges with requirement of Basin Plan exemption - Reject brine solution is very high in solids of about 1.8 million gallons per year (assuming 3.5 gpm reject stream) and will be sent off-site for disposal	**HIGH** - Because it involves a groundwater treatment system for a 35 gpm flow that treats all contaminants including NAPL, VOCs, metals and dissolved solids so the stream can be discharged off-site under a site-specific NPDES permit.	**HIGH** **-** Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: - 35 gpm pump and treatment system with 66 extraction pumps, large treatment equipment - PSCT and Gallery Well extraction -16 NAPL well extraction -GWTS treatment of PSCT groundwater and consumption of materials such as LPGAC and VPGAC -The addition of aggressive extraction would result in significant increase in energy use/GHG emissions due to continuous operation of extraction pumps and leachate treatment system. - Emissions during transport and off-site disposal of NAPL liquids, brine disposal - Filter media, RO/membrane filters for disposal. - Materials consumed include acids, alkalis, membranes, LPGAC and VPGAC.	**NOT RETAINED** **-** Because the timeframe for aquifer restoration would not be significantly different from other alternatives, and extremely high and uncertain cost and high energy consumption. - Implementability challenges include meeting the stringent site-specific NPDES discharge consistently over the long run. Administrative challenges associated with discharge of treated on-site groundwater into creek.

NOTES

1. Effectiveness and implementability are given ratings ranging from poor, poor to moderate, moderate, moderate to good or good.
2. Cost criterion and the green impacts assessment are given a rating from a range of low, low to moderate, moderate, moderate to high, or high.
3. A TI (Technical Impracticability) waiver of chemical-specific groundwater ARARs as presented in the TI evaluation (Appendix A) is assumed to be granted by the USEPA for FS Area 5 North.
4. Monitoring refers to periodic groundwater and soil vapor monitoring sitewide to monitor performance of the remedial components of the alternatives.
5. Anticipated capping remedies in FS Area 1 are expected to significantly reduce surface water infiltration and leaching to groundwater. Also, groundwater extraction flow rates are expected to decrease based on groundwater flow modeling.
6. Green impacts assessment (also referred to as environmental footprint) is a qualitative rating based on equipment using electricity such as groundwater extraction pumps, transfer pumps, and compressors, emissions, fuel and water use for trench excavation and refurbishment, and materials manufacture such as the LPGAC, VPGAC, ZVI, filters and their GHG footprint and transportation emissions for taking waste to off-site TSDF.

TABLE 10-6A-1
RISK ANALYSIS FOR P/S LANDFILL DEWATERING WITH HORIZONTAL WELLS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Item	Hazard/ Vulnerability	Description	Probability of Occurrence with No Risk Mitigation	Impact	Estimated Value of Impact	Consequences of Impact	Risk Mitigation	Probability of Occurrence with Risk Mitigation
Construction								
1	Insufficiently Draining the P/S Landfill (*Options 1 and 2*)	The landfill may not be sufficiently drained if the horizontal wells are either (1) not constructed along the bottom of the landfill, (2) constructed too far beneath the bottom of the landfill in the unweathered claystone, or (3) constructed at a spacing that is not dense enough (too few wells). The first issue will leave liquids in waste below the horizontal wells. The second issue may result in insufficient liquids moving from the bottom of the landfill through the unweathered claystone due to the low permeability of the claystone and low frequency of fractures in the claystone. The third issue may result in a drainage rate that is too slow because the ideal well spacing and hydraulic effect (zone of influence) of individual wells is not known.	High (< 75%)	Some free liquids (DNAPL, LNAPL, aqueous phase) may be left at the bottom of the landfill, at the south end of the landfill.	Install additional or replacement wells -$450,000 per well	Free DNAPL left behind may continue to be a source for ongoing DNAPL migration into the underlying claystone fractures. Aqueous phase liquids will create an incremental (negligible) increase in hydraulic head. This negligible increase in head will not substantially create an increase in the horizontal hydraulic gradient and contaminant migration underneath the PSCT trench.	Perform robust field investigation prior to detailed design so that the configuration of the contact between the waste and top of unweathered claystone is understood at an appropriate level of detail. This investigation would include pushing numerous Cone Penetrometer Test (CPT) borings into the landfill. However, even with a high density of CPT borings, uncertainty regarding the bottom configuration of the landfill will remain because the bottom of the landfill is likely benched and irregular resulting from original construction where the landfill was excavated to the weathered-unweathered claystone contact and then backfilled with waste material.	With sufficient CPT Borings (at least 8-12), Low (< 25%)
2	Uncontrolled Release of Landfill Liquids During Drilling and Well Construction (*Options 1 and 2*)	Installing the horizontal wells will entail drilling from the Sump 9B area (south of the landfill) northward into (or immediately underneath) the landfill at an overall upward angle. Landfill liquids (DNAPL, LNAPL, aqueous phase liquids) may flow uncontrollably by gravity to the south along the borehole during drilling or the installed well.	High (< 75%)	Uncontrolled flow of contaminated liquids (DNAPL, LNAPL, aqueous phase) could emerge from the borehole or well at the drilling location near the Sump 9B area.	Cleanup of liquids and impacted soils in impacted area -One small spill incident, $250,000	The landfill liquids would contaminate soil around the drill location and expose workers to hazardous materials.	Driller would utilize a pressure grouted surface casing (including a grouted annulus) keyed several feet into the clay barrier, combined with a blowout preventer at the surface to control flow back of liquids during well construction. Use secondary containment to contain potential liquids that may be uncontrollably released.	Assuming the clay barrier is at least 10' thick at the base, as described in the CSC Final Remediation Investigation Report (January, 2011) the risk of grouted surface casing leakage **and** blowout preventer failure is low (< 25%), even for multiple wells
3	Penetrating the Clay Barrier (*Option 1*)	Penetrating the clay barrier near the base would be required to adequately drain the south end of the landfill using horizontal wells. Drilling underneath the clay barrier may not facilitate proper drainage because of the low permeability of the claystone. Furthermore, drilling underneath the clay barrier may not allow placement of the horizontal wells at the optimum angle for proper drainage. The bore cannot be drilled upward at greater than approximately 20 degrees and would therefore bypass a portion of the NAPL pool at the bottom of the landfill, after the borehole passes underneath the clay barrier	High (< 75%)	Landfill liquids (DNAPL, LNAPL, aqueous phase liquids) may flow uncontrollably by gravity through the opening made in the clay barrier during drilling and emerge from the borehole or well at the drilling location near the Sump 9B area.	Cleanup of liquids and impacted soils in impacted area -One large spill incident, $1,000,000	The landfill liquids would contaminate soil around the drill location and expose workers to hazardous materials.	Driller would utilize a pressure grouted surface casing (including a grouted annulus) keyed several feet into the clay barrier, combined with a blowout preventer at the surface to control flow back of liquids during well construction.	Assuming the clay barrier is at least 10' thick at the base, as described in the CSC Final Remediation Investigation Report (January, 2011) the risk of grouted surface casing leakage **and** blowout preventer failure is low (< 25%), even for multiple wells
4	Loss of Borehole Circulation Fluids	Portions of the HDD borehole path are anticipated to encounter potentially fractured bedrock. Borehole fluid loss may occur particularly if dense frcacture network encountered, which would also impact ability to control borehole path.	High (< 75%)	Loss of borehole, significant smearing of borehole annulus to recover borehole,	Install additional or replacement wells -$450,000 per well	Result in poorly performing well due to difficult in removed drilliung mud during ewell development.	To recover borewhole typically drilling fluid is thicknened (increased density of drilling fluid), which may add to drive NAPL deeper into fractures.	If fractures exist along borehole path then difficult drilling conditions will need to be addressed. Due to the nature of the boreholes, horizontal to vertically inclined, loss of fluid circulation will significantly impact ability to install borehole and construct functioning well. High (<25%)
5	Improperly Controlling Path of Borehole (*Options 1 and 2*)	Installing the horizontal wells will require drilling through a variety of soil materials (alluvium, landfill waste, and claystone) and buried landfill debris at changing pitch angles. Interference associated with drums and other buried metal debris could interfere with conventional drill head tracking methods (walk over or wire line guidance system), which could compromise accurate placement of the well screen.	Moderate (< 50%)	Wells completed at the improper locations and/or elevations may result in incomplete draining of the landfill.	Install additional or replacement wells -$450,000 per well	Wells completed at the improper locations or elevations would need to be re-installed.	Driller could utilize a higher power sonde or gyro steering tool (GST) system, which is not sensitive to magnetic disturbances and does not require access to the surface. However, the GST cannot be used with the "knock-off"/expendable bit method described below. GST achieves a drill head tracking accuracy of 0.04 degrees azimuth and 0.02 degrees pitch.	With GST, low (<25%)

TABLE 10-6A-1
RISK ANALYSIS FOR P/S LANDFILL DEWATERING WITH HORIZONTAL WELLS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Item	Hazard/ Vulnerability	Description	Probability of Occurrence with No Risk Mitigation	Impact	Estimated Value of Impact	Consequences of Impact	Risk Mitigation	Probability of Occurrence with Risk Mitigation
6	Borehole Collapse (*Options 1 and 2*)	Installing the horizontal wells will require drilling through a variety of materials (alluvium, landfill waste, and claystone) and buried landfill debris at changing pitch angles. The landfill debris may partially collapse after the pilot bore is completed, which could preclude insertion of the well materials. Well materials are generally inserted into the bore in a single entry (blind end) application.	Moderate (< 50%)	Boreholes may collapse as a result of drilling through unconsolidated landfill waste materials and fractured bedrock.	Install additional or replacement wells -$450,000 per well	Collapsed borehole would need to be re drilled.	Driller would use oversized drill rod with a "knock-off"/expendable drill bit (patented technique) and insert the well materials inside the drill rods, effectively shielding them from borehole collapse. CH2M HILL has used this technique at several sites.	Low (< 25%)
7	Well Collapse (*Options 1 and 2*)	Constructed wells may collapse if the crush strength of the selected material (HDPE, stainless steel) is not sufficient, or if the well material is not chemically compatible with the landfill liquids. If not chemically compatible, landfill liquids may degrade the well materials which would cause them to weaken.	Low (< 25%)	Well material that is not sufficiently strong or becomes weakened from chemical incompatibility may collapse.	Install additional or replacement wells -$450,000 per well	Collapsed wells would decrease the hydraulic performance and drainage efficiently of the horizontal well network.	Materials will be selected so that they are chemically compatable and strong enough to avoid collapse	Low (< 25%)
8	Chemical Compatibility (*Options 1 and 2*)	Materials used in the process equipment (wellhead, pipes, tanks, valves, etc) may degrade and fail if not chemically compatible with the landfill liquids. This includes the "hard" components (pipes, tanks, etc.) and "soft" components (gaskets, O rings, etc).	Low (< 25%)	Materials that are chemically incompatible with the landfill liquids may become degraded and fail.	Cleanup of liquids and impacted soils in impacted area -One small spill incident, $50,000 -Replacement of pipes, tanks and/or valves, $50,000	Failed materials would result in uncontrolled releases.	Materials will be selected so that they are chemically compatible with the landfill liquids. This would include bench-top studies where materials are exposed to landfill liquids to verify chemical compatibility before materials are used in the field.	Low (< 25%)
9	Health and Safety during Construction (*Options 1 and 2*)	Workers may become exposed to contaminated contents from the landfill during drilling and well installation. The exposure may be from drilling mud that contains contamination or from uncontrolled release of raw landfill liquids that may "drain" downslope back to the drilling location.	Moderate (< 50%)	Workers may become exposed by direct contact with contamination or inhalation.	Potential worker exposures, medical testing and loss of work time, OSHA reporting, $50,000	Exposure to site workers may lead to short term (acute) and long-term (chronic) health issues.	Have Health and Safety Plan in place. Wear appropriate PPE (Level A/B/C) and perform air monitoring when the potential for exposure occurs. Stop work if ambient air concentrations exceed action levels. Stop work if drilling conditions indicate potential for uncontrolled release.	Low (< 25%)
Operation and Maintenance (Options 1 and 2)								
1	Well Efficiency and Clogging	The horizontal wells in the landfill may clog over time due to scaling/fouling, fines intrusion, or other factors.	Moderate (< 50%)	Well clogging may prevent liquids from effectively draining the landfill that could result in an accumulation of liquids in the landfill from natural seepage into the landfill.	Install replacement wells if clogged -$450,000 per well	A build-up of liquids in the landfill will create an incremental increase in hydraulic head and minimize the incremental benefits of decreasing the horizontal hydraulic gradient and contaminant migration underneath the PSCT trench.	Effectively develop wells during construction and, if necessary, perform redevelopment during O&M.	With periodic re-development every 2-5 years, low (<25%). Larger slot sizes can be selected to reduce the risk of clogging at the cost of increased fines pumping.
2	Uncontrolled Release During on-site O&M	Uncontrolled releases could occur from wells (at the wellhead), pipes, storage tanks, other process equipment. This would include transferring liquids from on-site storage tanks to trucks for transport of the liquids to the off-site disposal facility.	Low (< 25%)	Uncontrolled releases could contaminate soils. The impact to groundwater is not considered to be significant because there will be an HDPE cap overlying the Groundwater North area.	Cleanup of liquids and impacted soils in impacted area -One small spill incident, $250,000	Contaminated soil would need to be remediated.	Develop O&M and preventative maintenance procedures which include contingency measures and emply secondary containment at all times.	With secondary containment and contingency safety measures, low (<25%)
3	Water Coning	Water preferentially flows to the well than NAPL.	High (< 100%)	Result in high water production compared with NAPL production.	Install additional or replacement wells -$450,000 per well	Loss of design well functionality.	Extremely slow and controlled well production. However, well production will be controlled strictly by gravity flow to the well screen, through and unknown fluid distripution.	No above ground action can be implemented to control flow to the well. High (< 75%)
4	Health and Safety during O&M	Workers may become exposed to contaminated landfill liquids during operations and maintenance (while the landfill is draining). The exposure may occur during controlled O&M activities and accidental uncontrolled releases.	Low (< 25%)	Workers may become exposed by direct contact with contamination or inhalation.	Potential worker exposures, medical testing and loss of work time, OSHA reporting, $50,000	Exposure to site workers may lead to short term (acute) and long-term (chronic) health issues.	Have Health and Safety Plan in place. Shut-off wells and stop routine operations if conditions indicate potential for uncontrolled release. Wear protective clothing and perform air monitoring during all operations. Upgrade to higher safety level (Level A/B/C) if release occurs.	With secondary containment and contingency safety measures, low (<25%)
5	Uncontrolled Release During off-site Transport	Uncontrolled releases could occur while transporting the liquids to the off-site disposal facility.	Low (< 25%)	Uncontrolled releases during off-site transport of the liquids could (1) contaminate roadways and other public and private property and (2) lead to exposure to transporter drivers, the public, and the environment.	Cleanup of liquids and impacted soils in impacted area -One large spill incident, $1,000,000	Exposure to humans and ecological receptors may lead to short term (acute) and long-term (chronic) health issues. Contaminated soil and groundwater would need to be remediated.	O&M Procedures and emergency response procedures in place.	Low (<25%)
Probability of Occurrence		Low (< 25%) Moderate (< 50%) High (< 75%)						

TABLE 10-6B
SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER FS AREA 5 SOUTH
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
1	**No Action**	**POOR** **-** Aquifer restoration will take hundreds of years by dissolution, precipitation and other attenuation processes for inorganic contaminants. No long term monitoring is included to document the attenuation.	**NOT APPLICABLE**	**NONE**	**NONE**	**RETAINED** **-** Because it is required by the NCP
2	**Extraction (PCT-A, PCT-B) + Treat and Discharge to On-site Evaporation Pond + MNA + ICs + Monitoring**	**MODERATE** **-** Would address the objective of containing or controlling on-site sources and mitigating potential off-site migration. Source reduction of organics and inorganics to groundwater would occur with the anticipated capping remedy for FS Area 1, the Maintenance Shed Area and FS Area 3 south of the PSCT including the former Ponds A/B area. - The PCT-A and PCT-B extraction would reliably capture COCs at the site perimeter. Effective at controlling migration of dissolved phase COCs primarily VOCs and metals. - COC mass reduction is modest and aquifer restoration would take hundreds of years.	**GOOD** **-** Because this alternative is already operating currently. No significant technical or administrative challenges expected. - The total extracted flows are expected to decrease with the increase in the total capping sitewide expected as part of the site remedy that would significantly reduce infiltration.	**LOW TO MODERATE** **-** No significant capital expense because trench wells already exist but costs are included for replacement of PCT-B trench to improve extraction operations.	**LOW TO MODERATE** **-** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: - PCT-A, PCT-B extraction	**RETAINED** **-** Because it is well proven as it is the currently operating approach and achieves the objective of controlling contaminants and preventing off-site migration. - Source reduction of organics and inorganics is achieved by the anticipated capping in FS Area 1, the MSA and the remedy for locations south of the PSCT.
3	**Extraction (PCT-A, PCT-B) + Treat and Discharge Off-site + MNA + ICs + Monitoring**	**MODERATE** **-** Would address the objective of containing or controlling on-site sources and mitigating potential off-site migration. Source reduction of organics and inorganics to groundwater would occur with the anticipated capping remedy for FS Area 1 and the Maintenance Shed Area and capping or excavation remedy for FS Area 3 south of the PSCT including the former Ponds A/B area. - The PCT-A and PCT-B extraction would reliably capture COCs at the site perimeter. - Effective at controlling migration of dissolved phase COCs primarily VOCs and metals. - COC mass reduction is modest and aquifer restoration would take hundreds of years. - Treatment of inorganics will enable discharge off-site but would generate brine wastes that would need to be managed or disposed off-site	**MODERATE** - Challenges with obtaining a site-specific NPDES permit that would require a Basin Plan exemption for discharge to the B Drainage. - Lower implementability rating than Alternative 2 because of technical challenges with on-site treatment of inorganics by reverse osmosis for off-site discharge of groundwater - The total extracted flows are expected to decrease with the increase in the total capping sitewide expected as part of the site remedy that would significantly reduce infiltration. - Challenges with managing brine wastewater from inorganics treatment	**MODERATE TO HIGH** - Includes capital and O&M cost for reverse osmosis treatment of inorganics in groundwater for off-site discharge - Includes brine off-site disposal cost	**MODERATE TO HIGH** - Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: - PCT-A, PCT-B extraction - reverse osmosis and brine concentrator treatment - Off-site disposal of reject brine	**RETAINED** **-** Because it is similar to Alternative 2 but supports the sitewide alternatives that do not include an on-site evaporation pond by treating inorganics in groundwater for discharge off-site
4	**Extraction (PCT-A) + In-Situ Reactive Wall (PCT-B) + MNA + ICs + Monitoring**	**POOR TO MODERATE** **-** Would address the objective of containing or controlling on-site sources and mitigate potential off-site migration. The source of VOCs and inorganics would be controlled by the anticipated capping of FS Area 1, the Maintenance Shed Area and the remedy for the area just south of the PSCT including the former Ponds A/B area. - Some uncertainty about the effectiveness of PCT-B reactive wall and reliability of capture COCs at the site perimeter. The reactive wall technology has not been tested on-site. It is known to be effective for VOCs but there is uncertainty in effectiveness with a combination of metals with different redox chemistries at this site. - COC mass reduction is modest and aquifer restoration would take hundreds of years.	**MODERATE TO GOOD** **-** Because the extraction component of the alternative is implemented and being used currently. - Some technical challenges can be expected with installation of reactive walls but not considered a significant challenge.	**MODERATE** **-** Includes cost for construction of in-situ reactive wall at PCT-B and additional monitoring for reactive wall	**LOW** **-** Green and sustainability impacts are based on electricity, fuel usage and GHG emissions for: - PCT-A extraction - during construction and replacement of ZVI reactive wall at PCT-B - Impacts are rated lower than Alt 2 because of lower groundwater extraction rates from the PCT-A and the reactive wall is a passive technology that does not consume fuel or electricity.	**RETAINED** **-** Because this alternative achieves the objectives of containing contaminants and source reduction from anticipated capping as discussed in Alternative 1. - Aboveground liquids treatment capacity is significantly lower than Alternative 2 because PCT-A flow rate decreases significantly with the anticipated capping remedies on-site.

TABLE 10-6B
SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER FS AREA 5 SOUTH
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
5	**Extraction (PSCT Westside Extension) + Extraction (PCT-A, PCT-B) + MNA + ICs + Monitoring**	**MODERATE** **-** Would address the objective of containing or controlling on-site sources, mitigate potential off-site migration. PSCT extraction is added to reduce the source south of the PSCT and BTA. - PSCT Westside extraction is not likely to result in significant extraction with the new wells because the water table is expected to drop below the weathered-unweathered claystone contact. On a separate note, there is significant attenuation in the concentration of VOCs between wells RG-4B and downgradient wells RG-5B and WP-3S south of the PSCT indicative of a stable plume that is not migrating. Hence the risk reduction achievable with the PSCT Westside extraction is limited. - Effective at controlling migration of dissolved phase COCs primarily VOCs and metals in Upper HSU. However, COC mass reduction is modest compared to total mass of contaminants in groundwater and aquifer restoration would still take hundreds of years.	**MODERATE** **-** Challenges with recovering any significant groundwater flow from the new PSCT Westside extension wells.	**MODERATE TO HIGH** - Because it includes capital and O&M cost of the PSCT Westside extension.	**MODERATE TO HIGH** **-** Green and sustainability impacts are based on energy usage primarily as electricity, fuel usage and GHG emissions for: - Construct PSCT Westside extension with 2 extraction wells - Additional PSCT flow from extension treated in GWTS - PCT-A, PCT-B extraction	**NOT RETAINED** **-** Because the water table is expected to drop significantly with the anticipated site capping remedies in FS Area 1 and 3 and the amount of groundwater flow in the Upper HSU is expected to drop significantly. It is not likely that the PSCT Westside extension is going to capture a significant amount of groundwater due to the drop in the water table. Besides groundwater VOC concentrations do attenuate rapidly south of the PSCT and the BTA, so the PSCT Westside extension is not achieving a significant risk reduction.
6	**Aggressive Extraction (40 New Extraction Wells) + Extraction (PCT-A, PCT-B) + Treat and Discharge Off-site + MNA + ICs + Monitoring**	**MODERATE** **-** Will pump and treat a large volume of groundwater over a long period of time. But the fractured bedrock conditions would pose a challenge due to VOCs and inorganics diffused into the bedrock matrix that would slowly diffuse out with extraction. Even if VOC concentrations in groundwater are significantly reduced, VOCs will continue to diffuse out of the rock matrix. - Radius of influence of wells would be limited by the bedrock conditions. - Potential air emissions from the treatment system would be a concern. - Large amounts of waste (e.g. brine from RO) would be generated that would either need to be managed on-site in evaporation ponds or sent off-site for disposal. - Concentrations will decrease over decades of operation but will not restore site groundwater to MCLs. Aquifer restoration will still take hundreds of years and not be significantly different from previous alternatives.	**POOR TO MODERATE** - Challenges with obtaining a site-specific NPDES permit that would require a Basin Plan exemption for discharge to the B Drainage. - Technical challenges with capturing groundwater from the extraction wells in this bedrock formation can be expected. - Significant well clogging can be anticipated due to high TDS. - Water treatment can pose a significant challenge with high TDS and metals in meeting NPDES discharge standards. - Reject brine solution volume of about 1.8 million gallons per year will be need to be disposed off-site	**HIGH** -Because it involves a leachate treatment plant for a 30 gpm flow that treats all contaminants including VOCs, metals and dissolved solids so the stream can be discharged off-site under a site-specific NPDES permit - Includes brine off-site disposal cost	**HIGH** **-** Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: - 30 gpm pump and treatment system with 40 extraction pumps, large treatment equipment - PCT-A, PCT-B extraction - The addition of inorganics treatment with reverse osmosis would result in significant increase in energy use/GHG emissions. - Emissions during transport and off-site disposal of NAPL liquids and brine disposal - Filter media, RO/membrane filters for disposal. - LPGAC sent off-site for regeneration - Materials consumed include RO membranes, LPGAC and VPGAC	**RETAINED** **-** Though there would be implementability challenges, extremely high and uncertain cost and high energy consumption, this alternative is retained for detailed evaluation as representative of an aggressive restoration alternative because there would not be a TI waiver for Area 5 South. Administrative challenges associated with discharge of treated on-site groundwater into creek can also be anticipated.

NOTES

1. Effectiveness and implementability are given ratings ranging from poor, poor to moderate, moderate, moderate to good or good.
2. Cost criterion and the green impacts assessment are given a rating from a range of low, low to moderate, moderate, moderate to high, high or very high.
3. A TI (Technical Impracticability) waiver of chemical-specific groundwater ARARs as presented in the TI evaluation (Appendix A) is assumed to be granted by the USEPA for FS Area 5 North.
4. Monitoring refers to periodic groundwater and soil vapor monitoring sitewide to monitor performance of the remedial components of the alternatives.
5. Anticipated capping remedies for the site are expected to significantly reduce surface water infiltration and potential for contaminant migration. Also, groundwater extraction flow rates are expected to decrease based on groundwater flow modeling.
6. Green impacts assessment (also referred to as environmental footprint) is a qualitative rating (low, medium, high) based on equipment using electricity such as groundwater extraction pumps, transfer pumps, and compressors, emissions, fuel and water use for trench excavation and refurbishment, and materials manufacture such as the LPGAC, VPGAC, ZVI, filters and their GHG footprint and transportation emissions for taking waste to off-site TSDF.

TABLE 10-6C
SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER FS AREA 5 WEST
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
1	**No Action**	**POOR** **-** Aquifer restoration will take hundreds of years by dissolution, precipitation and other attenuation processes for inorganic contaminants. No long term monitoring is included to document the attenuation.	**NOT APPLICABLE**	**NONE**	**NONE**	**RETAINED** **-** Because it is required by the NCP
2	**Monitored Natural Attenuation + ICs**	**POOR** **-** Would not achieve the RAO of controlling potential off-site migration **-** While intrinsic biodegradation of VOCs in groundwater has been well documented, the attenuation of inorganics has not been studied in detail. Some attenuation is anticipated due to the capping of the source areas and reduced leaching to groundwater. Historical data analysis indicates relatively stable concentrations. The attenuation rate for inorganics assuming capping remedies is estimated in Appendix D to be approximately 220 years for arsenic based on dispersion and dilution effects.	**GOOD** **-** Because there are no technical challenges in implementation. Monitoring wells are already there at the site.	**LOW** - Just monitoring costs	**NONE** - Minor impacts from sampling activities and from drilling any additional wells	**NOT RETAINED** **-** Because it does not include perimeter control to ensure no off-site migration.
3	**Extraction (PCT-C) + Treat and Discharge to On-site Evaporation Pond + MNA + ICs + Monitoring**	**MODERATE** **-** Would address the RAO of containing or controlling on-site sources and mitigate potential off-site migration. Sources would be controlled by anticipated capping of RCRA Canyon/WCSA and the A-5 and A-Series Ponds. - The PCT feature would reliably capture any contaminants at the site perimeter. Effective at controlling migration of dissolved metals. - COC mass reduction is modest and aquifer restoration would take several decades. Appendix D estimates a 220-year timeframe to bring highest metal concentrations (arsenic) to MCL levels primarily by capping to reduce leaching to groundwater.	**GOOD** **-** Because this alternative is already operating currently. No significant challenges are expected. The total extracted flows are expected to decrease with the increase in total capping sitewide expected as part of the site remedy.	**LOW TO MODERATE** **-** No significant capital expense because trench wells already exist but costs are included for replacement of PCT-C trench to improve extraction operations. - Low O&M costs due to minimal treatment requirements	**LOW TO MODERATE** **-** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: - PCT-C extraction	**RETAINED** **-** Because it is well proven as it is the currently operating approach and achieves the RAOs.
4	**Extraction (PCT-C) + Treat and Discharge Off-site + MNA + ICs + Monitoring**	**MODERATE** **-** Would address the RAO of containing or controlling on-site sources and mitigate potential off-site migration. Sources would be controlled by anticipated capping of RCRA Canyon/WCSA and the A-5 and A-Series Ponds. - The PCT feature would reliably capture any contaminants at the site perimeter. Effective at controlling migration of dissolved metals. - Treatment of inorganics will enable discharge off-site but would generate brine wastes that would need to be managed or disposed off-site - COC mass reduction is modest and aquifer restoration would take several decades. Appendix D estimates a 220-year timeframe to bring highest metal concentrations (arsenic) to MCL levels primarily by capping to reduce leaching to groundwater. [5]	**MODERATE** - Lower implementability rating than Alternative 3 because of technical challenges with on-site treatment of inorganics by reverse osmosis for off-site discharge of groundwater - Challenges with obtaining a site-specific NPDES permit that would require a Basin Plan exemption for discharge to the B Drainage. - Challenges with managing brine wastewater (840,000 gallons)from inorganics treatment that would need off-site disposal	**MODERATE TO HIGH** - Includes capital and O&M cost for reverse osmosis treatment of inorganics in groundwater for off-site discharge - Includes brine off-site disposal cost	**MODERATE TO HIGH** **-** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: - PCT-C extraction - reverse osmosis and brine concentrator treatment - off-site brine disposal	**RETAINED** **-** Because it is similar to Alternative 3 but supports the sitewide alternatives that do not include an on-site evaporation pond by treating inorganics in groundwater for discharge off-site

TABLE 10-6C
SCREENING OF REMEDIAL ALTERNATIVES FOR GROUNDWATER FS AREA 5 WEST
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

ALT NO.	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	GREEN IMPACTS ASSESSMENT	SCREENING COMMENTS
5	**In-Situ Reactive Wall (PCT-C) + MNA + ICs + Monitoring**	**POOR TO MODERATE** **-** Would address the RAO of containing or controlling on-site sources and mitigate potential off-site migration. Sources would be controlled by anticipated capping of RCRA Canyon/WCSA and the Ponds A-5 and A-Series. - The reactive wall technology has not been tested on-site. It is known to be effective for VOCs but there is uncertainty in effectiveness with a combination of metals with different redox chemistries at this site. - However, COC mass reduction is modest and aquifer restoration would take several decades. Appendix D estimates a 220-year timeframe to bring highest metal concentrations (arsenic) to MCL levels primarily by capping to reduce leaching to groundwater.	**MODERATE TO GOOD** **-** Because the extraction component of the alternative is implemented and being used currently. - Some technical challenges can be expected with installation of reactive walls but not considered significant.	**MODERATE** **-** Includes capital cost for PCT-C construction and low O&M cost	**LOW** **-** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: - Construction and replacement of the ZVI reactive walls. - Impacts are rated lower than Alt 2 because the reactive wall is a passive technology that does not consume fuel or electricity.	**RETAINED** **-** Because this alternative achieves the RAOs and is lower and as a representative of an in-situ technology for perimeter capture.
6	**Aggressive Extraction (40 New Extraction Wells) + Extraction (PCT-C) + Treat and Discharge Off-site + MNA + ICs + Monitoring**	**MODERATE** **-** Will pump and treat a large volume of groundwater over a long period of time. But the fractured bedrock conditions would pose a challenge due to inorganics diffused into the bedrock matrix that would slowly diffuse out with extraction. - Radius of influence of wells would be limited by the bedrock conditions. - Potential air emissions from the treatment system would be a concern. Large amounts of waste (e.g. brine from RO) would be generated. - Concentrations will decrease over decades of operation but will not restore site groundwater to MCLs. Aquifer restoration will still take decades not significantly different from other alternatives.	**POOR TO MODERATE** - Challenges with obtaining a site-specific NPDES permit that would require a Basin Plan exemption for discharge to the B Drainage. - Technical challenges with capturing groundwater from the extraction wells in this bedrock formation can be expected. - Significant well clogging can be anticipated due to high TDS. - Water treatment can pose a challenge with high TDS and metals in meeting NPDES discharge standards. - Reject brine solution that is very high in solids of about 1 million gallons per year will need to be disposed off-site.	**HIGH** **-** Because it involves a groundwater treatment system for a 20 gpm flow that treats all contaminants including metals and dissolved solids so the stream can be discharged off-site under a site-specific NPDES permit	**HIGH** **-** Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: - 20 gpm pump and treatment system with 40 extraction pumps, large treatment equipment - PCT-C extraction - Filter media, RO/membrane filters for disposal. - LPGAC sent off-site for regeneration - Off-site brine disposal - Materials consumed include RO membranes, LPGAC and VPGAC	**RETAINED** **-** Though there would be implementability challenges, extremely high and uncertain cost and high energy consumption, this alternative is retained for detailed evaluation as representative of an aggressive restoration alternative because there would not be a TI waiver for Area 5 West. Administrative challenges associated with discharge of treated on-site groundwater into creek can also be anticipated.

NOTES

1. Effectiveness and implementability are given ratings ranging from poor, poor to moderate, moderate, moderate to good or good.
2. Cost criterion and the green impacts assessment are given a rating from a range of low, low to moderate, moderate, moderate to high, high or very high.
3. A TI (Technical Impracticability) waiver of chemical-specific groundwater ARARs as presented in the TI evaluation (Appendix A) is assumed to be granted by the USEPA for Area 5 North.
4. Monitoring refers to periodic groundwater and soil vapor monitoring sitewide to monitor performance of the remedial components of the alternatives.
5. Anticipated capping remedies for the FS Area 2 and pond closure remedies (FS Area 4) are expected to significantly reduce infiltration and leaching to groundwater. This will cut off the contaminant flux to groundwater and in the long term the flushing of clean groundwater from the north will transport residual metals contaminants towards the PCT-C where it would be captured.
6. Green impacts assessment (also referred to as environmental footprint) is a qualitative rating (low, medium, high) based on equipment using electricity such as groundwater extraction pumps, transfer pumps, and compressors, emissions, fuel and water use for trench excavation and refurbishment, and materials manufacture such as the LPGAC, VPGAC, ZVI, filters and their GHG footprint and transportation emissions for taking waste to off-site TSDF.

TABLE 11-1
SELECTED REMEDIAL ALTERNATIVES FOR DETAILED 9-CRITERIA ANALYSIS BY FS AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
1	**FS Area 1** PCB landfill, Burial Trench Area (BTA), Central Drainage Area (CDA) and existing Capped Landfills Area	Soil - Metals, Organics	- Protect Ecological receptors - Reduce surface water infiltration and control potential for groundwater contaminant migration - Storm water controls	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. RCRA-Equivalent Mono (Soil) Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls+ ICs + Monitoring This remedial alternative involves installing a RCRA cap on the PCB Landfill (4.4 acres) and installing a RCRA equivalent mono (soil) cap on the Burial Trench Area (5.5 acres) and the Central Drainage (18.8 acres) as shown in Figure 11-1A. The RCRA equivalent monocap is 5-feet of engineered low permeability claylike soil to prevent infiltration. These caps would be tied into the adjacent Capped Landfills Area. The RCRA cap and the RCRA equivalent monocap prevents ecological-receptors from potential exposures to shallow soil (0-5' bgs) contaminants and reduces rainwater infiltration into soil and groundwater in order to reduce further VOC migration in soil and groundwater. The stormwater will be directed by surface drains towards a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site to Pond 13 and offsite to the B-Drainage through or around the wetlands.
				3. Evapotranspirative (ET) Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA cap on the PCB Landfill (4.4 acres) and installing a ET soil cap on the Burial Trench Area (5.5 acres) and the Central Drainage (18.8 acres) as shown in Figure 11-2A. The ET soil cap is 5 feet of engineered low permeability claylike soil with a compacted 1-foot foundation layer and a 4-foot vegetative layer that is lightly compacted to about 85% of maximum dry density (ASTM D 1557). The soil cap is intended to store water, allow growth of vegetation and removal of soil moisture through transpiration. These caps would be tied into the adjacent Capped Landfills Area. The RCRA cap and the ET cap prevents ecological-receptors from potential exposures to shallow soil (0-5' bgs) contaminants and significantly reduces rainwater infiltration into soil and groundwater in order to reduce further VOC migration in soil and groundwater. The stormwater will be directed by surface drains towards a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site to Pond 13 and offsite to the B-Drainage through or around the wetlands.
				4. RCRA Cap (PCB Landfill, BTA, CDA) + Stormwater Controls + ICs + Monitoring This remedial alternative would involve installing a RCRA cap on the PCB Landfill, Burial Trench Area (BTA) and the Central Drainage Area (CDA) as shown in Figure 11-3A. The RCRA cap would prevent direct contact with metals and organic contaminants in shallow soil and address the risk to ecological-receptors. It would also prevent rainwater infiltration into groundwater. These caps would be tied into the adjacent Capped Landfills Area. The total surface area for each of these capped areas will be 4.4 acres for PCB Landfill, 5.5 acres for BTA and 18.8 acres for CDA for a total of 28.7 acres of cap. The cap cross-section is shown in Figure 11-3A. The stormwater will be directed by surface drains towards a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site to Pond 13 and offsite to the B-Drainage through or around the wetlands.
				5. Excavate (BTA) (20') + Excavate (CDA remedial area) (5') + RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Dispose Excavated Soil Offsite + Stormwater Controls + ICs + Monitoring This remedial alternative would involve installing a RCRA cap on the PCB Landfill as in the other alternatives. It addresses the ecological risks of the other subareas by excavating the shallow soil (5') within a portion of the Central Drainage Area and the entire Burial Trench Area to remove waste from the trenches as shown in Figure 11-4A. The areas targeted for excavation in the CDA are based on the exceedances of the sitewide cleanup goals for metals and organics in shallow (0-5') soils which were defined by the RI. This remedial alternative assumes the entire BTA would be excavated down to 20 feet bgs to remove waste deposited in the trenches (but if trench wastes are deeper than 20 feet bgs, the excavation would correspondingly be deeper). The excavated wastes would be sent offsite to a permitted landfill for disposal. The stormwater will be directed by surface drains towards a culvert near PSCT-1 and then flow through a drainage channel to the southern portion of the site to Pond 13 and offsite to the B-Drainage through or around the wetlands.
2	**FS Area 2** RCRA Canyon, West Canyon Spray Area (WCSA)	Soil – Metals Stormwater - Metals	- Protect Ecological receptors - Reduce surface water infiltration and control potential for groundwater contaminant migration - Stormwater controls - Eliminate seeps	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Ecological-cap (West slope RCRA Canyon, WCSA remedial area) (2') + Grading/BMPs (Uncapped areas) + Stormwater Controls + ICs + Monitoring This alternative involves capping metals-impacted soils in the RCRA Canyon and WCSA which were identified as requiring remediation in the revised ERA (Appendix C of this FS) with an "ecological or ecological-cap" which is 2-foot of clean soil with a vegetative layer (Figure 11-5A). The ecological cap would be placed in the RCRA Canyon west slope (8.4 acres) and over a portion of the WCSA east slope (5.5 acres). The ecological cap is intended to eliminate potential exposure to ecological-receptors. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. Some portions of the west slope and the WCSA that are steeper than 2:1 would be covered with turf reinforcement mats to minimize erosion. Since the ecological cap does not eliminate surface water infiltration or potential seeps at the foot of the RCRA Canyon, the stormwater from the entire RCRA Canyon/WCSA would be collected in an onsite evaporation pond where it would be managed.
				3. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon) (5') + Excavation (WCSA) (5') + Grading/BMPs (Uncapped Areas) + Storm water Controls + ICs + Monitoring This remedial alternative involves installing a RCRA equivalent mono (soil) cap on the west slope of the RCRA Canyon which is approximately 8.4 acres. The RCRA equivalent mono cap is 5 feet of low permeability claylike soil. The RCRA equivalent cap will control potential exposures to ecological receptors and will reduce surface water infiltration. A portion of the WCSA (5.5 acres) will be excavated and the soil used as fill in Pond A-5 (Figure 11-6A). The excavated portions of the WCSA will be backfilled to match grades. This remedial alternative assumes some grading and additional borrow soil is required to reduce the

TABLE 11-1
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CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				steepness of some of the sloped areas in order to install the cap. The final surfaces of the western slope of the RCRA Canyon will be sloped and include surface drains to allow drainage of storm water from the west slope of the RCRA canyon to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to the B-Drainage wetlands and discharged offsite via the General permit. The uncapped area of the east slope and WCSA will implement grading and BMPs as part of erosion control. The surface water runoff from the eastern slope of the RCRA Canyon (i.e. the WCSA) will be collected in a new onsite evaporation pond which will be constructed in the footprint of the A-Series Pond where it would be managed.
				4. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon, WCSA remedial area) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA equivalent mono (soil) cap on the west slope of the RCRA Canyon (8.4 acre) and a portion of the WCSA (5.5 acres) as shown on Figure 11-7A. The RCRA equivalent mono cap is 5-foot of low permeability claylike soil. The RCRA equivalent cap will control potential exposures to ecological receptors and will significantly reduce water infiltration. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. The final surfaces of the western slope of the RCRA Canyon and WCSA will be sloped and include surface drains to allow drainage of storm water from the west slope of the RCRA canyon and WCSA to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to the B-Drainage wetlands and discharged offsite via the General permit. Grading and BMPs are included to reduce erosion in the uncapped areas (19.3 acres). The surface water runoff from the uncapped eastern slope of RCRA Canyon and WCSA will be collected in a new onsite evaporation pond where it would be managed.
				5. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon) (5') + Excavate (WCSA) (5') + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA equivalent mono soil cap on the west slope of the RCRA Canyon which is approximately 8.4 acre as shown in Figure 11-8A. The RCRA equivalent mono cap is 5-foot of low permeability claylike soil. The RCRA equivalent cap will control potential exposures to ecological receptors and will reduce surface water infiltration. A portion of the WCSA will be excavated and the soil used as fill in Pond A-5. The excavated portions of the WCSA will be backfilled to match grades and compacted to achieve conductivities in the range of 10^{-4} to 10^{-6} cm/s. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. The uncapped remaining areas (19.3 acres) of the site will be graded to reduce slopes (max 2:1 slope) and covered with 2 feet of clean soil. The final surfaces of the west slope of the RCRA Canyon and the WCSA will be sloped and include surface drains to allow drainage of storm water from the entire RCRA canyon to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to the B-Drainage and discharged offsite via the General permit.
				6. RCRA-equivalent Hybrid Cap (West slope RCRA Canyon) (5') + Excavate (WCSA remedial area) + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA-equivalent hybrid cap on the west slope of the RCRA Canyon which is approximately 8.4 acre as shown in Figure 11-9A. The RCRA equivalent hybrid cap is a spiked 60-mil HDPE liner with a drainage layer and a 2-foot soil cover. The RCRA equivalent cap will control potential exposures to ecological receptors and will significantly reduce water infiltration. A portion of the WCSA will be excavated and the soil used as fill in Pond A-5. The excavated portions of the WCSA will be backfilled to match grades and compacted to 85% relative compaction with a 6-inch vegetative layer on top. The uncapped remaining areas (19.3 acres) of the site will also be graded to reduce slopes (max 2:1 slope) and covered with 2 feet of clean soil. The stormwater will be collected by surface drains to a concrete channel that allows drainage into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to the B-Drainage and discharged offsite via the General NPDES permit.
				7. Evapotranspirative (ET) Cap (West slope RCRA Canyon) (5') + Excavation (WCSA remedial area) + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a ET soil cap on the west slope of the RCRA Canyon which is approximately 8.4 acre as shown in Figure 11-10A. The ET soil cap is 5 feet of engineered low permeability claylike soil that includes a vegetative layer that is 4 feet thick that is lightly compacted to about 85% and a 1-foot thick compacted foundation layer. The soil cap is intended to store water, allow growth of vegetation and removal of soil moisture through transpiration. This ET cap will control potential exposures to ecological receptors and will reduce surface water infiltration. A portion of the WCSA will be excavated and the soil used as fill in Pond A-5. The excavated portions of the WCSA will be backfilled to match grades and compacted to 85% relative compaction with a 6-inch vegetative layer on top. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas (2:1) in order to install the cap. The uncapped remaining areas (19.3 acres) of the site will also be graded to reduce slopes (max 2:1 slope) covered with 2 feet of clean soil. The final surfaces of the west slope of the RCRA Canyon and the WCSA will be sloped and include surface drains to allow drainage of storm water from the entire RCRA canyon to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to the B-Drainage and discharged offsite via the General permit.
				8. RCRA Equivalent Hybrid Cap (entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA equivalent hybrid cap on the entire RCRA Canyon and WCSA that is a total of 33 acres as shown on

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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				Figure 11-11A. The RCRA equivalent hybrid cap is a HDPE liner equipped with studs and spikes intended for sloped areas and a 2-foot vegetative soil cover. The RCRA equivalent cap will control potential exposures to ecological receptors and will significantly reduce water infiltration. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of the sloped areas to less than 2:1 in order to install the cap. The final surfaces of the western slope of the RCRA Canyon and WCSA will be sloped and include surface drains to allow drainage of storm water from the west slope of the RCRA canyon and WCSA to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to the B-Drainage and discharged offsite via the General permit. The surface water runoff from the uncapped south end of WCSA will be collected in a new onsite evaporation pond where it would be managed.
				9. Evapotranspirative (ET) Cap (entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring This remedial alternative involves installing a RCRA equivalent hybrid cap on the entire RCRA Canyon and WCSA that is a total of 33 acres as shown on Figure 11-12A. The ET soil cap is 5 feet of engineered low permeability claylike soil that includes a vegetative layer that is 4 feet thick that is lightly compacted to about 85% and a 1-foot thick compacted foundation layer. The soil cap is intended to store water, allow growth of vegetation and removal of soil moisture through transpiration. This ET cap will control potential exposures to ecological receptors and will reduce surface water infiltration. This remedial alternative assumes some grading and additional borrow soil is required to reduce the steepness of some of the sloped areas in order to install the cap. The final surfaces of the western slope of the RCRA Canyon and WCSA will be sloped and include surface drains to allow drainage of storm water from the west slope of the RCRA canyon and WCSA to flow into a new retention basin that will be constructed in the footprint of the former Pond A-5. This stormwater will be sent by pipeline to the B-Drainage and discharged offsite via the General permit. The surface water runoff from the uncapped south end of the WCSA will be collected in a new onsite evaporation pond where it would be managed.
3	**FS Area 3** Former Pond and Pads, Roadways, Remaining Onsite areas, Maintenance Shed Area, Liquids Treatment Area - 9 hotspot locations with Tier 1 ecological risks - 1 hotspot RISBON-59 as potential groundwater contaminant	Soil - Metals, Organics	- Protect Ecological receptors - Reduce infiltration and control potential for groundwater contaminant migration - Stormwater controls	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. RCRA Cap (Locations 2, 3 and 4) + Excavate/New Asphalt Cap (Location 1) (5') + Groundwater Monitoring (Location 10) + Grading/BMPs + Stormwater Controls + ICs + Monitoring This remedial alternative involves extending the RCRA cap which is discussed for Area 1 over the Maintenance Shed Area (Location 2) and Hotspot Locations 3 and 4 south of the PSCT (Figure 11-13A). This RCRA cap will extend for approximately 300 feet south of the PSCT and run parallel to it over Locations 3 and 4. The surface of the cap is sloped and includes surface drains to direct stormwater on the cap to flow southeast towards the drainage channel near PSCT-1. The stormwater in the drainage channel will flow under a culvert on RCF Road to Pond 13 and then offsite through the wetlands under the site's General NPDES permit. Portions of Hotspot Location 1 that are not already covered by asphalt or concrete will be excavated and the entire location will be paved with a new 4" asphalt cap. For Hotspot Location 10 (RISBON-59), the remedial alternative proposes two additional UHSU downgradient groundwater monitoring wells to ensure that there is no impact in the future to groundwater from this deep soil impacted area.
				3. RCRA Cap (Locations 2)[2] + Excavate ((Location 3) (20'); (Location 4) (5')) + Excavate/New Asphalt Cap (Location 1) (5') + Groundwater Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This remedial alternative involves extending the RCRA cap which is discussed for Area 1 over the Maintenance Shed Area (Location 2) and excavation of Hotspot Locations 3 and 4 south of the PSCT for disposal in the PCB Landfill (Figure 11-14A). The excavation will be backfilled with clean borrow soil. The surface of the cap would be sloped and includes surface drains to direct stormwater on the cap to flow southeast towards the drainage channel near PSCT-1. The stormwater in the drainage channel will flow under a culvert on RCF Road to Pond 13 and then offsite through the wetlands under the site's General NPDES permit. Hotspot Location 1 will be excavated and paved with a new 4" asphalt cap. For Hotspot Location 10 (RISBON-59), the remedial alternative proposes two additional UHSU downgradient groundwater monitoring wells to ensure that there is no impact in the future to groundwater from this deep soil impacted area.
				4. RCRA Cap (Location 2) + Excavate ((Location 3) (20'); (Location 4) (5'); (Location 10) (50'))/Place in PCB Landfill/Backfill + Excavate/New Asphalt Cap (Location 1) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This remedial alternative involves extending the RCRA cap which is discussed for Area 1 over the Maintenance Shed Area (Location 2) and excavation of Hotspot Locations 3 and 4 south of the PSCT for disposal in the PCB Landfill (Figure 11-15A). The excavation will be backfilled with clean borrow soil. The surface of the cap would be sloped and includes surface drains to direct stormwater on the cap to flow southeast towards the drainage channel near PSCT-1. The stormwater in the drainage channel will flow under a culvert on RCF Road to Pond 13 and then offsite through the wetlands under the site's General NPDES permit. Hotspot Location 1 will be excavated and paved with a new 4" asphalt cap. For Hotspot Location 10 (RISBON-59), the alternative includes excavation of an area about 175 feet by 175 feet with a total depth of 50 feet below RCF Road for a total impacted soil volume of 65,000 cy for onsite disposal at the PCB Landfill.
				5. Excavate (Locations 2, 4) (5'); (Location 3) (20'); (Location 10) (50')/Offsite Disposal/Backfill + Excavate/New Asphalt Cap (Location 1) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring This remedial alternative assumes excavation of the top 5 feet of Locations 1, 2 and 4 covering an area of 5.4 acres and excavation of Location 3 (former Ponds A/B, 2.2 acres) down to 20 feet bgs for a total of 115,000 cy and Location 10 that is an area about 175 feet by 175 feet with a total excavation depth of

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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				50 feet below RCF Road for a total impacted soil volume of 65,000 cy for offsite disposal at a permitted landfill (Figure 11-16A). These excavations are backfilled with clean soil imported from offsite sources due to the large amount of fill needed. After backfilling Location 1 will be covered with a new asphalt cap. The stormwater runoff from these backfilled areas will be graded such that the stormwater sheet flows towards the southern portion of the site to Pond 13 and then offsite through the wetlands under the site's General permit.
4	**FS Area 4** Stormwater Ponds and Treated Liquid Impoundments - Ponds RCF, A-series, 18, A-5, 13	Surface water, sediment - Metals, Organics	- Protect Ecological receptors and Human receptors (onsite workers, trespassers) - Reduce surface water infiltration and control potential for groundwater contaminant migration - Stormwater controls	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Ecological-Cap (RCF, A-Series Pond) (2') + Construct 11-acre Evaporation Pond north of RCF Pond + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This remedial alternative involves managing existing storm water in the A-Series Pond and RCF Pond as discussed in the body of the FS to reduce or eliminate those volumes prior to FS construction. The impacted bottom areas of the RCF and A-Series Pond sediments will be raised to 415 feet MSL and 425 feet bgs respectively and capped with an ecological-cap (discussed previously) which is comprised of a 2-foot soil cover. The remedial alternative assumes the construction of a new lined 11-acre evaporation pond south of the PSCT (Figure 11-17A). The evaporation pond includes a double HDPE lined bottom with a leachate collection system and leak detection system as discussed in Section 10.1.1.8. Ecological protection for the evaporation pond is discussed in Section 10.1.4. A new lined retention basin will be constructed in the footprint of Pond A-5 (which will be partially backfilled to ensure the pond bottom is above projected groundwater levels). Pond 18 will be backfilled to match surface grades and ensure storm water flows off that area of the site and will be capped with a RCRA cap. Pond 13 will be partially backfilled filled using the Pond 13 dike and then lined with a HDPE material to serve as a stormwater retention basin that discharge offsite to the B drainage under the site's General NPDES permit.
				3. Ecological-Cap (RCF Pond, Segregate East RCF) (2') + Construct Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls[3, 4] + ICs + Monitoring This alternative involves managing liquids in the existing stormwater ponds as discussed in detail in the FS (the management plan utilizes a new lined evaporation pond which is constructed in the footprint of the A-Series Pond). The RCF Pond is lined with an ecological-cap after it is drained and partially filled to raise the western portion of the pond bottom to 415 feet MSL while the east end of the RCF is segregated with a 5-foot high berm (Figure 11-18A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line (which also serves to expand the size of the new evaporation pond to 11 acres). The A-Series Pond bottom is then lined with a double HDPE liner with a leachate collection system and lead detection system to convert it to the evaporation pond. Ecological protection for the evaporation pond is discussed in Section 10.1.4. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The other ponds (Pond A-5 and 13) are filled to raise the pond bottom and then lined to serve as retention basins that drain storm water to the wetlands that discharge offsite to the B-Drainage under the site's General NPDES permit.
				4. Ecological-Cap (RCF Pond) (2') + Construct 11-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This alternative involves managing liquids in the existing stormwater ponds as discussed in detail in the FS. The RCF Pond is lined with an ecological-cap after it is drained and the pond bottom is raised to 415 feet MSL with borrow soil (Figure 11-19A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line (which also serves to expand the size of the new evaporation pond to 11 acres). The A-Series Pond bottom is then lined with a double HDPE liner with a leachate collection system and lead detection system to convert it to the evaporation pond. Ecological protection for the evaporation pond is discussed in Section 10.1.4. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The other ponds (Pond A-5 and 13) are filled to raise the pond bottom and then lined to serve as retention basins that drain storm water to the wetlands that discharge offsite to the B drainage under the site's General NPDES permit.
				5. Ecological-Cap (RCF Pond, portion of A-Series Pond) + Construct 6-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Ponds A-5, 13) + Stormwater Controls + ICs + Monitoring This alternative involves managing liquids in existing stormwater ponds as discussed in detail in the FS. The RCF Pond is lined with an ecological-cap after it is drained and the bottom raised to 415 feet MSL across the entire pond (Figure 11-20A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line and a portion of the A-Series Pond is then converted to a 6-acre evaporation pond that is constructed as six 1-acre pond cells with the remaining area covered with an ecological-cap. The A-Series Pond bottom is lined with a double HDPE liner with a leachate collection system and lead detection system to convert it to the evaporation pond. Ecological protection for the evaporation pond is discussed in Section 10.1.4. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The ecological-caps on the RCF and A-Series Ponds would be sloped to direct stormwater towards Pond 13 and then to the wetlands. The other ponds (Pond A-5 and 13) are backfilled with soil and lined to serve as retention basins to drain storm water to the wetlands that discharge offsite to the B-Drainage under the site's General NPDES permit.
				6. Ecological-Cap (RCF Pond, A-Series Pond) (2') + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls[3, 4] + ICs + Monitoring This alternative involves managing liquids in the existing stormwater ponds as discussed in the FS. This alternative does not include an evaporation pond and complements the remedial alternatives in Area 5 groundwater where the groundwater is treated for both VOCs and inorganics. The RCF Pond is lined with an

TABLE 11-1
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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				ecological-cap after it is drained and the pond bottom is raised to 415 feet MSL with borrow soil (Figure 11-21A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line and then covered with an ecological-cap. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The other ponds (Pond A-5 and 13) are filled to raise the pond bottom and then lined to serve as retention basins that drain storm water to the wetlands and then offsite to the B-Drainage under the site's General NPDES permit.
				7. ET Cap (RCF Pond, portion of A-Series Pond) + Construct 6-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Ponds A-5, 18)) + Stormwater Controls + ICs + Monitoring This alternative involves managing liquids in existing stormwater ponds as discussed in detail in the FS. The RCF Pond is lined with an ET cap after it is drained and the bottom raised to 415 feet MSL (Figure 11-22A). The A-Series Pond bottom is raised to 425 feet MSL with fill soil from the northeast shore line. A portion of the A-Series Pond is then converted to a 6-acre lined evaporation pond as six 1-acre pond cells. The A-Series Pond bottom is lined with a double HDPE liner with a leachate collection system and lead detection system to convert it to the evaporation pond. Ecological protection for the evaporation pond is discussed in Section 10.1.4.The remaining portion of the A-Series Pond is covered with an ET cap. Pond 18 is capped with a RCRA cap and graded to allow stormwater to sheet flow south to the A-Series Pond. The other ponds (Pond A-5 and 13) are backfilled with soil and lined to serve as retention basins to drain storm water to the wetlands that discharge offsite to the B-Drainage under the site's General NPDES permit.
				8. Excavate (RCF Pond, A-Series Pond) (5') + Construct new 11-acre Lined Evaporation Pond (North of RCF Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring This alternative involves constructing a new 11-acre lined evaporation pond north of the RCF Pond and managing the existing stormwater in the ponds by pumping the remaining stormwater to the new evaporation pond. After emptying the two ponds, the RCF and A-Series Pond sediments are excavated down to 5 feet below surface and backfilled/graded to ensure the stormwater flows out of the ponds through the culvert under RCF Road (Figure 11-23A). The RCF and A-Series Pond will be raised to 415 feet MSL and 425 feet bgs respectively to avoid groundwater intrusion. Additional backfill soil would also be needed on the to ensure there is adequate slope to drain water to the culvert under RCF Road. The evaporation pond includes a double HDPE lined bottom with a leachate collection system and leak detection system as discussed in Section 10.1.1.8. Ecological protection for the evaporation pond is discussed in Section 10.1.4. From this culvert, the stormwater would then go through Pond 13 to the wetlands and offsite B-drainage under the site's General NPDES permit.
5	**FS Area 5 North Groundwater**	Groundwater - VOCs, Organics, Inorganics, DNAPL, LNAPL	- Contain and/or control contamination sources within the site boundary, where groundwater restoration is not technically practicable - Provide control and containment for TI zone in Area 5 North and South - Protect offsite groundwater resources - Mitigate potential off-site migration of groundwater contamination by perimeter control - Contain and/or control migration of DNAPL in source areas where removal is not technically practicable - Remove DNAPL in source areas where extraction is practical and where significant reduction in risk will result - Contain and/or control	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Extraction (PSCT, Gallery Well) + Treat and Discharge PSCT Groundwater to Onsite Evaporation Pond + ICs + Monitoring This remedial alternative includes continued extraction of liquids and DNAPL from Gallery Well and PSCT extraction features as is required to meet current action levels (Figure 11-24A). The DNAPL and liquids from the Gallery Well would be sent to an offsite TSDF for disposal similar to how they are currently managed. The P/S Landfill is estimated to be dewatered in approximately 10 years with the assumed capping in FS Area 1 and the Gallery Well extraction. The PSCT liquids would be treated onsite for removal of organics (via an upgraded GAC system). The treated PSCT liquids will be pumped to the new lined evaporation pond which we are proposing be located in the footprint of the A-Series Pond. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				3. Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Monitoring (12 new LHSU wells) + Treat and Discharge PSCT Groundwater to Onsite Evaporation Pond + ICs + Monitoring This alternative includes continued extraction of liquids and NAPL from the Gallery Well and PSCT trenches as discussed in Alternative 2. In addition, this alternative adds NAPL-only extraction from 16 new NAPL-only wells in the Upper HSU under the P/S Landfill. Four wells will be located on Bench 1 and four more on a new bench road between Bench 1 and Bench 2. In addition, two new bench roads south of Bench 1 will have four wells each near the toe of the P/S Landfill (Figure 11-25A). NAPL-only extraction anticipates utilizing 4-inch diameter wells which are pumped as necessary when sufficient DNAPL and LNAPL has collected in the well. Twelve new LHSU monitoring wells are proposed just upgradient of PSCT-1 and PSCT-4 to monitor any potential VOC migration under the PSCT in the LHSU. The PSCT liquids would be treated onsite for removal of organics (via an upgraded GAC system) and pumped to a new upgraded onsite treatment system designed to remove organics. The treated PSCT liquids will be pumped to a new lined evaporation pond in the A-Series Pond footprint as in Alternative 2. The extracted DNAPL and leachate will be sent offsite to a permitted facility for disposal. The P/S Landfill is estimated to be dewatered in approximately 10 years with the assumed capping in FS Area 1 and the Gallery Well extraction. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				4. Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Monitoring (12 new LHSU wells) + Treat and Discharge PSCT Groundwater Offsite (No Evaporation Pond) + ICs + Monitoring This alternative includes continued extraction of liquids and NAPL from the Gallery Well and PSCT trenches and NAPL-only extraction as discussed in Alternative 3. Also, twelve new LHSU monitoring wells are proposed just upgradient of PSCT-1 and PSCT-4 to monitor the any potential VOC migration under the PSCT in the LHSU. In this alternative, the PSCT liquids would be treated onsite for removal of organics and inorganics using carbon adsorption, and reverse osmosis for offsite discharge to the B-Drainage in accordance with the site-specific NPDES permit (Figure 11-26A). This alternative assumes that there is no evaporation pond onsite. The extracted DNAPL and leachate will be sent offsite to a permitted facility for disposal. The P/S Landfill is estimated to be

TABLE 11-1
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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
			the migration of LNAPL in source areas	dewatered in approximately 10 years with the assumed capping in FS Area 1 and the Gallery Well extraction. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				5. Extraction (PSCT, Gallery Well) + Extraction (Aggressive, 16 Large Diameter NAPL wells) + Extraction (NAPL-only in CDA, 4 existing wells) + Monitoring (12 new LHSU wells) + Treat and Discharge to Onsite Evaporation Pond + ICs + Monitoring This alternative includes continued extraction of liquids and NAPL from Gallery Well and PSCT trench extraction as it is currently being implemented. This alternative adds continuous aggressive total fluids extraction from 16 new large-diameter (8") NAPL wells in the vicinity of RIPZ-13 in the P/S landfill in the Upper HSU (Figure 11-27A). Four wells will be located on Bench 1 and four more on a new bench road between Bench 1 and Bench 2. In addition, two new bench roads south of Bench 1 will have four wells each near the toe of the P/S landfill. Also, four existing monitoring wells in the CDA would be converted to LNAPL skimmer wells to recover floating product and twelve new LHSU monitoring wells are proposed just upgradient of PSCT-1 and PSCT-4 to monitor the any potential VOC migration under the PSCT in the LHSU. The aggressive extraction of total fluids is expected to produce an average flow rate of up to10 gpm of landfill leachate that is treated in a new Liquids Treatment Plant (LTP) which removes organics. The P/S Landfill is estimated to be dewatered in approximately 5 years with the assumed capping in FS Area 1 and the aggressive extraction in the P/S Landfill. The treated leachate from the LTP along with the treated PSCT liquids will be discharged to a new evaporation pond located north of the RCF Pond to handle the additional volumes of treated liquids. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				6. Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells) + Extraction (NAPL-only in CDA, 4 existing wells) + Monitoring (12 new LHSU wells) + Treat and Discharge to Onsite Evaporation Pond + ICs + Monitoring This alternative includes extraction from the PSCT and Gallery Well and adds 5 horizontal wells under the P/S Landfill to dewater it (Figure 11-28A). The horizontal well extraction of total fluids is expected to produce an initial total groundwater flow rate of up to 10 gpm (5.2 million gallons per year) of landfill leachate that would decrease with time and these liquids would be sent offsite for disposal. The P/S Landfill is estimated to be dewatered in approximately 5 years with the assumed capping in FS Area 1 and the aggressive extraction in the P/S Landfill. The PSCT liquids would be treated onsite for removal of organics (via an upgraded GAC system) and pumped to a new upgraded onsite treatment system designed to remove organics. The treated PSCT liquids will be pumped to a new lined evaporation pond in the A-Series Pond footprint as in Alternative 2. Also, 4 existing monitoring wells in the CDA would be converted to LNAPL extraction wells and twelve new LHSU monitoring wells are proposed just upgradient of PSCT-1 and PSCT-4 to monitor the any potential VOC migration under the PSCT in the LHSU. The extracted NAPL and concentrated leachate that is not treated will be sent offsite to a permitted facility for disposal. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				7. Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells) + Extraction (NAPL-only in CDA, 12 new wells) + Extraction (4 new LHSU wells) + Monitoring (8 new LHSU wells) + Treat and Discharge Offsite + ICs + Monitoring This alternative includes extraction from the PSCT and Gallery Well and adds 5 horizontal wells under the P/S Landfill to dewater it (Figure 11-29A). The horizontal well extraction of total fluids is expected to produce an initial total groundwater flow rate of up to 10 gpm (5.2 million gallons per year) of landfill leachate that would decrease with time and these liquids would be sent offsite for disposal. The P/S Landfill is estimated to be dewatered in approximately 5 years with the assumed capping in FS Area 1 and the aggressive extraction in the P/S Landfill. The PSCT liquids would be treated onsite for removal of organics and inorganics and discharged offsite under a site-specific NPDES permit. Also, four existing monitoring wells in the CDA would be converted to LNAPL skimmer wells to recover floating product, four new LHSU wells are proposed just upgradient of PSCT-1 and PSCT-4 for groundwater extraction and eight new LHSU wells are proposed for monitoring to prevent any potential VOC migration under the PSCT. The extracted NAPL and concentrated leachate will be sent offsite to a permitted facility for disposal. Brine wastes generated from the onsite LTP with dissolved solids treatment will be trucked offsite for disposal to a permitted facility. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
5	**FS Area 5 South Groundwater**	Groundwater – VOCs, Inorganics	- Contain and/or control contamination sources within the site boundary, where groundwater restoration is not technically practicable - Protect offsite groundwater resources - Mitigate potential off-site migration of groundwater contamination by perimeter control	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Extraction (PCT-A, PCT-B) + Treat/Discharge to Onsite Evaporation Pond + MNA + ICs + Monitoring This remedial alternative includes continued extraction of liquids from PCT-A and PCT-B as is required to meet current action levels to ensure no offsite migration. The extracted PCT-A and PCT-B liquids will be pumped to a new lined evaporation pond which we are proposing to be located in the footprint of the A-Series Pond (Figure 11-30A). Note that anticipated capping remedies for the FS Areas and 1 and 3 would minimize leaching to groundwater. This combined with natural attenuation of organics would reduce contaminant concentrations over the long term. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				3. Extraction (PCT-A, PCT-B) + Treat and Discharge Offsite + MNA + ICs + Monitoring This remedial alternative includes continued extraction of liquids from PCT-A and PCT-B as in Alternative 2. The extracted PCT-A and PCT-B liquids will be treated for organics and inorganics and discharged offsite in accordance with the site-specific NPDES permit (Figure 11-31A). The treatment will include reverse osmosis for inorganics and if needed, LPGAC for organics. The reverse osmosis used to treat inorganics produces waste brine that is assumed to be sent offsite for disposal. Note that anticipated capping remedies for the FS Areas and 1 and 3 would minimize leaching to groundwater. This combined with natural attenuation of organics would reduce contaminant concentrations over the long term. Sitewide groundwater and soil vapor monitoring is included as

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No.	FS Areas for Evaluation	Primary Media, COCs	Remedial Objectives	Remedial Alternatives for FS Evaluation
				discussed in Section 10.1.6.
				4. Extraction (PCT-A) + In-situ Reactive Wall (PCT-B) + MNA + ICs + Monitoring This alternative assumes that the PCT-B trench is converted to a passive, in-situ reactive wall treatment using ZVI instead of extraction (Figure 11-32A) and extraction at the PCT-A. The extracted PCT-A liquids will be pumped to a new lined evaporation pond which we are proposing to be located in the footprint of the A-Series Pond. The in-situ reactive wall is constructed by cutting four slots in the clay barrier along the trench. Note that anticipated capping remedies for the FS Areas and 1 and 3 upgradient of PCT-B would minimize leaching to groundwater. This combined with natural attenuation of organics would reduce contaminant concentrations over the long term. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				5. Aggressive Extraction (40 New Large Diameter Wells, Area 5 South) + Extraction (PCT-A, PCT-B) + Treat and Discharge Offsite + MNA + ICs + Monitoring This alternative is an aggressive hydraulic extraction that would require a high density of groundwater extraction wells be installed as an attempt to achieve MCLs in groundwater throughout the site. The alternative would be required since a Technical Impracticability waiver is not included for this groundwater area. It involves installation of 40 new large diameter extraction wells distributed across Area 5 South at approximately 150-foot spacing (Figure 11-33A). Extraction from these wells would be continuous and is assumed to produce about 0.5 gpm per well and including PCT flows for a total of about 30 gpm of low VOCs and inorganics-impacted groundwater being treated aboveground in a dedicated treatment system for discharge offsite in accordance with a site-specific NPDES permit. Extraction at the PCT-A and PCT-B is also included to provide capture at the perimeter. The treatment will include reverse osmosis for inorganics and if needed, LPGAC for organics. The reverse osmosis used to treat inorganics produces waste brine that is assumed to be sent offsite for disposal. Note that anticipated capping remedies for the FS Areas and 1 and 3 upgradient of PCT-A and PCT-B would minimize leaching to groundwater. This combined with natural attenuation of organics would reduce contaminant concentrations over the long term.
5	**FS Area 5 West Groundwater**	Groundwater - Inorganics	- Contain and/or control contamination sources within the site boundary, where groundwater restoration is not technically practicable - Protect offsite groundwater resources - Mitigate potential off-site migration of groundwater contamination by perimeter control	**1. No Action** The No Action alternative is included as required by CERCLA guidance**.**
				2. Extraction (PCT-C) + Treat/Discharge to Onsite Evaporation Pond + MNA + ICs + Monitoring This remedial alternative includes continued extraction of liquids from PCT-C as is required to meet current action levels to prevent offsite migration. The extracted PCT-C liquids will be pumped to the new lined evaporation pond which we are proposing be located in the footprint of the A-Series Pond (Figure 11-34A). Note that anticipated capping remedies for the RCRA Canyon/WCSA (FS Area 2) and Pond A-5 and A-Series Pond (FS Area 4) that are upgradient would minimize leaching to groundwater and this would attenuate inorganic concentrations over the long term. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				3. Extraction (PCT-C) + Treat and Discharge Offsite + MNA + ICs + Monitoring This remedial alternative includes continued extraction of liquids from PCT-C as in Alternative 2. The extracted PCT-C liquids will be treated for inorganics and discharged offsite in accordance with the site-specific NPDES permit (Figure 11-35A). . The treatment will include reverse osmosis for inorganics and if needed, LPGAC for organics (if any). The reverse osmosis used to treat inorganics produces waste brine that is assumed to be sent offsite for disposal. Note that anticipated capping remedies for the RCRA Canyon/WCSA (FS Area 2) and Pond A-5 and A-Series Pond (FS Area 4) that are upgradient would minimize leaching to groundwater and this would attenuate inorganic concentrations over the long term. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				4. In-situ Reactive Wall (PCT-C) + MNA + ICs + Monitoring This alternative assumes that the PCT-C trench is converted to a passive, in-situ reactive wall treatment using ZVI instead of extraction (Figure 11-36A). It is constructed by cutting four slots in the clay barrier along the 1,500-foot length of the trench. Note that anticipated capping remedies for the RCRA Canyon/WCSA (FS Area 2) and Pond A-5 and A-Series Pond (FS Area 4) that are upgradient would minimize leaching to groundwater and this would attenuate inorganic concentrations over the long term. Sitewide groundwater and soil vapor monitoring is included as discussed in Section 10.1.6.
				5. Aggressive Extraction (40 new Large Diameter Wells, Area 5 West) + Extraction (PCT-C) + Treat and Discharge Offsite + MNA + ICs + Monitoring This alternative is an aggressive hydraulic extraction that would require a high density of groundwater extraction wells be installed as an attempt to achieve MCLs in groundwater throughout the site. The alternative would be required since a Technical Impracticability waiver is not included for this groundwater area. It involves installation of 40 new large diameter extraction wells distributed across Area 5 West at approximately 150-foot spacing (Figure 11-37A). Extraction from these wells would be continuous and is assumed to produce about 0.05 gpm per well and including PCT-C flow for a total of about 20 gpm of inorganics-impacted groundwater being treated aboveground in a dedicated treatment system for discharge offsite in accordance with a site-specific NPDES permit. The treatment will include reverse osmosis for inorganics and if needed, LPGAC for organics (if any). The reverse osmosis used to treat inorganics produces waste brine that is assumed to be sent offsite for disposal. Extraction of the PCT-C is assumed to be included to provide capture at the perimeter. Note that anticipated capping remedies for the RCRA Canyon/WCSA (FS Area 2) and Pond A-5 and A-Series Pond (FS Area 4) that are upgradient of PCT-C would minimize leaching to groundwater and would attenuate inorganic concentrations over the long term.

TABLE 11-2
DETAILED ANALYSIS OF ALTERNATIVES FOR FS AREA 1
PCB LANDFILL, CENTRAL DRAINAGE AREA AND BURIAL TRENCH AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment [1]	Compliance with ARARs	Long-Term Effectiveness [2]	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost[3]	Green Impacts Assessment
1	**No Action**	**NO** -Would not be protective because it does not include any remediation or long term controls and future owners or construction workers could encounter contamination.	**NO** -This alternative would not meet the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NONE**	**NONE**
2	**RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because the cap would ensure that there are no exposures to on-siteon-site workers or to ecological receptors. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. -Will be in compliance with requirements for RCRA landfill closure for the PCB landfill.	**MODERATE TO GOOD** -The soil cap controls potential for long term exposure to contaminants in soil. There is no residual risk because long term cap maintenance and monitoring and ICs are included. The PCB Landfill is appropriately capped with a RCRA cap and the mono soil caps on the CDA and BTA minimize infiltration and protect groundwater. -Stormwater controls would reduce erosion and potential contaminant migration through sediments.	**POOR** -No reduction in toxicity, mobility and volume through soil treatment. But mobility is significantly reduced based on one RCRA cap and two soil caps that would significantly reduce leachate production or contaminant migration in deep soil and groundwater.	**MODERATE TO GOOD** -No significant risk of exposure or environmental impacts because the RCRA cap and soil caps would not involve excavation of contaminated soils. It would be constructed out of clean soils that are borrowed from the off-site NW Borrow areas and other off-site locations. Limited excavation of shallow soils during leveling could pose minor risks for construction workers.	**GOOD** -No significant technical challenges except for capping in some sloped areas. The steep slopes will be reduced by the cut/fill grading during the leveling process prior to capping. -Several vendors available for implementation. Capping is a well-developed technology.	**MODERATE TO HIGH** Capital = $12,286,000 Annual Cost = $318,000/year Present Worth = $17,253,000 (3%, 30-yr) Present Worth = $13,422,000 (7%, 30-yr) Present Worth = $22,117,000 (3%, 100-yr) Present Worth = $14,176,000 (7%, 100-yr)	**MODERATE** Green and sustainability impacts are based on cut/fill grading of 250,000 cy and borrow soil/compaction for caps of 250,000 cy, materials manufacture, transport, installation (4.4 acres HDPE, GCL liner). Assume use of on-siteon-site water in ponds minimizes use of other clean water supplies.
3	**Evapotranspirative (ET) Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because the cap would ensure that there are no exposures to on-site workers or to ecological receptors. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. -Will be in compliance with requirements for RCRA landfill closure for the PCB landfill.	**MODERATE TO GOOD** -The soil cap controls potential for long term exposure to contaminants in soil. There is no residual risk because long term cap maintenance and monitoring and ICs are included. The PCB Landfill is appropriately capped with a RCRA cap and the ET soil caps on the CDA and BTA minimize infiltration and protect groundwater. -Stormwater controls would reduce erosion and potential contaminant migration through sediments.	**POOR** -No reduction in toxicity, mobility and volume through soil treatment. But mobility is significantly reduced based on one RCRA cap and two soil caps that would significantly reduce leachate production or contaminant migration in deep soil and groundwater.	**MODERATE TO GOOD** -No significant risk of exposure or environmental impacts because the RCRA cap and soil caps would not involve excavation of contaminated soils. It would be constructed out of clean soils that are borrowed from the off-siteoff-site NW Borrow areas and other off-site locations. Limited excavation of shallow soils during leveling could pose minor risks for construction workers.	**GOOD** -No significant technical challenges except for capping in some sloped areas. The steep slopes will be reduced by the cut/fill grading during the leveling process prior to capping. -Several vendors available for implementation. Capping is a well-developed technology.	**MODERATE TO HIGH** Capital = $11,177,000 Annual Cost = $318,000/year Present Worth = $16,267,000 (3%, 30-yr) Present Worth = $12,572,000 (7%, 30-yr) Present Worth = $21,036,000 (3%, 100-yr) Present Worth = $13,311,000 (7%, 100-yr)	**MODERATE** Green and sustainability impacts are based on cut/fill grading of 250,000 cy and borrow soil/compaction for caps of 250,000 cy, materials manufacture, transport, installation (4.4 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.

TABLE 11-2
DETAILED ANALYSIS OF ALTERNATIVES FOR FS AREA 1
PCB LANDFILL, CENTRAL DRAINAGE AREA AND BURIAL TRENCH AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment [1]	Compliance with ARARs	Long-Term Effectiveness [2]	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost[3]	Green Impacts Assessment
4	**RCRA Cap (PCB Landfill, BTA, CDA) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because cap would ensure that there are no exposures to on-site workers or to ecological receptors. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. -Will be in compliance with requirements for RCRA landfill closure for the PCB landfill.	**MODERATE TO GOOD** -The RCRA cap across all three areas controls potential for long term exposure to contaminants. There is no residual risk because it includes long term cap maintenance and monitoring and ICs. The RCRA cap across all three areas eliminates rainwater infiltration and associated migration of contaminants in groundwater. -Stormwater controls would reduce erosion and potential contaminant migration through sediments.	**POOR** -No reduction in toxicity, mobility and volume through soil treatment. But mobility is significantly reduced based on the three RCRA caps that would minimize leachate production or contaminant migration in deep soil and groundwater.	**MODERATE TO GOOD** -No significant risk of exposure or environmental impact because the RCRA cap would not involve excavation of contaminated soil. It would be constructed out of imported clean soils from the off-site NW Borrow Area. Limited excavation of shallow soils could pose minor risks for construction workers.	**GOOD** -No significant technical challenges except for capping in some sloped areas. The steep slopes will be reduced by the cut/fill grading during the leveling process prior to capping. -Several vendors available for implementation. RCRA caps are a well-developed technology.	**MODERATE TO HIGH** Capital = $14,018,000 Annual Cost = $318,000/year Present Worth = $18,793,000 (3%) Present Worth = $14,749,000 (7%) Present Worth = $23,806,000 (3%) Present Worth = $15,526,000 (7%)	**MODERATE** Green and sustainability impacts are based on cut/fill grading of 250,000 cy and borrow soil/compaction for caps of 200,000 cy, materials manufacture, transport, installation (28 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.
5	**Excavate (Entire BTA (20') + CDA remedial area (5'))/Off-site Disposal + RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because excavation and placement in PCB landfill would prevent exposure to outdoor soil contaminants. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including requirements for a worker health and safety program, and the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. -Will be in compliance with requirements for RCRA landfill closure for the PCB landfill.	**MODERATE** -Controls potential for long term exposure to contaminants. No residual risk because it includes long term cap maintenance and monitoring and ICs. The backfilled CDA and BTA excavations are capped with low permeability soil cap which would minimize rainwater infiltration. -Stormwater controls would reduce erosion and potential contaminant migration through sediments. Concern with transfer of risk to off-site locations.	**POOR TO MODERATE** -There is reduction in toxicity, mobility and volume based on the excavation in BTA and CDA but no soil treatment is included. Mobility of contaminants at the PCB Landfill would be prevented by the RCRA cap and significantly reduced in the BTA by the excavation. Surface water infiltration in the CDA and BTA would be minimized by the RCRA equivalent soil cap and the drains.	**POOR TO MODERATE** -The excavation of highly impacted VOC soils in BTA would pose significant risk to the construction workers and possible emissions and odors to the off-site residents. The backfilled CDA and BTA areas are capped with a RCRA equivalent soil cap with clean off-site borrow soil. Limited excavation of shallow soils during leveling could pose minor risks for construction workers.	**MODERATE** -Significant technical challenges and uncertainties are expected with excavation of the burial trenches in the BTA and handling of the wastes would pose a risk to on-site workers. -Minor challenges expected with the excavation in the CDA to address shallow (0-5') soils associated with the excavating sloped areas. Several vendors available for implementation.	**HIGH** Capital = $31,785,000 Annual Cost = $318,000/year Present Worth = $34,592,000 (3%) Present Worth = $28,365,000 (7%) Present Worth = $39,456,000 (3%) Present Worth = $29,119,000 (7%)	**HIGH** Green and sustainability impacts are based on excavation of 230,000 cy, cut/fill grading of 130,000 cy and borrow soil/compaction for caps of 350,000 cy, materials manufacture, transport, installation (4.4 acres HDPE, GCL liner). Transport of impacted soils off-site for disposal. Assume use of on-site water in ponds minimizes use of other clean water supplies.

TABLE NOTES

1. Ratings for the threshold criteria are provided as "Yes" or "No". For example, "Yes" would indicate the alternative provides adequate protection of health and environment or that the alternative is in compliance with ARARs.
2. Ratings for the five balancing criteria are provided on a rating scale from a range of low rating (poor) to highest rating (good) for each criterion. For the cost criterion, the ratings vary from low to very high.
3. Detailed cost estimate sheets are provided in Appendix E. The present worth costs are presented in 2014$ for a 30-year and 100-year timeframe with a 3% and 7% discount rate as indicated in parentheses. Costs are approximate (+50%/-30%) and include a contingency of 35-50%.
4. Stormwater controls refers to V-drains, drainage channels, erosion controls, silt fences, geogrids, etc to transfer storm water quickly out of the impacted areas of the site and minimize erosion. It is included for all active remedial alternatives and is intended to control potential contaminant migration through storm water.
5. The stormwater plan involves direct water through perimeter ditches towards PSCT-1 and then transfer through a culvert and through a concrete drainage channel that flows through the footprint of the RCF pond and then discharged off-site to the B-drainage.
6. Green impacts assessment is a qualitative rating of environmental impacts (footprint) based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative. The higher the rating, the greater the impacts and hence, the less green the alternative.

TABLE 11-3
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 2
RCRA CANYON AND WEST CANYON SPRAY AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [3]	Green Impacts Assessment
1	**No Action**	**NO** -Would not be protective because it does not include any remediation or long term controls and future owners or construction workers could encounter contamination.	**NO** -This alternative would not meet the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NONE**	**NONE**
2	**Ecological-Cap (West Slope RCRA Canyon, WCSA Remedial Area) (2') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because the cap would ensure that there are no exposures to ecological receptors and on-site workers. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**POOR TO MODERATE** -Controls direct contact exposure to soil contaminants for ecological receptors with the ecological-cap but long term performance of the ecological-cap is uncertain. May need more frequent cap repair and maintenance. -All stormwater would need to be directed to the on-site evaporation pond which may pose challenges with pond water handling during wet years. Rainwater infiltration will not be significantly reduced by this alternative.	**POOR** -No reduction in toxicity, mobility and volume through soil treatment because this is primarily a capping technology that does not treat the soils. Ecological-cap would not significantly reduce infiltration.	**MODERATE TO GOOD** -No significant risk because the RCRA cap would be constructed out of imported soils. Minor risks to on-site workers with cut/fill grading of impacted soils during leveling for the cap.	**MODERATE TO GOOD** -Some technical challenges with capping and grading with steep slopes in the canyon. Challenges with long term maintenance of ecological-cap on slopes. Several vendors available for implementation.	**MODERATE** Capital = $8,269,000 Annual Cost = $364,000/year Present Worth = $14,596,000 (3%, 30-yr) Present Worth = $10,923,000 (7%, 30-yr) Present Worth = $20,385,000 (3%, 100-yr) Present Worth = $11,820,000 (7%, 100-yr)	**LOW TO MODERATE** Green and sustainability impacts based on cut/fill grading of 130,000 cy, borrow soil and compaction of 49,000 cy, construction of larger evaporation pond (+ 9 acres), materials (jute mesh, TRMs) manufacturing and installation, grading/BMPs for 19 acres
3	**RCRA-Equivalent Mono Soil Cap (West Slope RCRA Canyon) (5') + Excavate (WCSA Remedial Area) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls (Segregate Capped and Uncapped Area SW) + ICs + Monitoring**	**YES** -Would be protective because cap would ensure that there are no exposures to ecological receptors and on-site workers. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE** -Controls potential for long term direct contact exposure to contaminants with a RCRA-equivalent cap and an excavation for the two remedial areas. The cap would meet the performance requirements with respect to hydraulic conductivity and thus minimize infiltration through impacted soils. This along with the drains that collect stormwater would eliminate the potential for seeps in the RCRA Canyon. -Uncapped areas would be graded with BMPs to minimize erosion. Stormwater from uncapped areas would be directed to the proposed on-site evaporation pond until it can be shown to be clean for off-site discharge under the site's General Permit.	**POOR** -No reduction in toxicity, mobility and volume as a result of soil treatment but the RCRA-equivalent cap and excavation would significantly reduce mobility of contaminants based on the RCRA-equivalent soil cap that would achieve the $1x10^{-6}$ cm/s performance standard for hydraulic conductivity. Reduced infiltration will reduce potential for seeps in the RCRA Canyon.	**MODERATE TO GOOD** -No significant risk because the soil caps would be constructed out of imported clean soils mostly from the off-site NW borrow area. Minor risks to on-site workers with cut/fill grading of impacted soils during leveling for the cap and through dust from excavation.	**MODERATE TO GOOD** -Some technical challenges with capping and grading with steep slopes in the canyon. Several vendors available for implementation.	**MODERATE** Capital = $9,105,000 Annual Cost = $333,000/year Present Worth = $14,730,000 (3%, 30-yr) Present Worth = $11,177,000 (7%, 30-yr) Present Worth = $19,508,000 (3%, 100-yr) Present Worth = $11,918,000 (7%, 100-yr)	**MODERATE** Green and sustainability impacts based on cut/fill grading of 100,000 cy, excavation of 44,000 cy, borrow soil and compaction of 123,000 cy, construction of larger evaporation pond (+ 3 acres), materials (jute mesh, TRMs) manufacturing and installation, grading/BMPs for 19 acres
4	**RCRA- Equivalent Mono Soil Cap (West Slope RCRA Canyon, WCSA Remedial Area) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because cap would ensure that there are no exposures to ecological receptors and on-site workers. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE** -Controls potential for long term exposure to contaminants with a RCRA-equivalent cap for both remedial areas. The cap would meet the performance requirements with respect to hydraulic conductivity and thus minimize infiltration through impacted soils. This along with the drains that collect stormwater would	**POOR** -No reduction in toxicity, mobility and volume as a result of soil treatment but mobility is significantly reduced based on the RCRA equivalent soil cap that would achieve the $1x10^{-6}$ cm/s performance standard for hydraulic	**MODERATE TO GOOD** -No significant risk because the soil caps would be constructed out of imported clean soils mostly from the off-site NW borrow area. Minor risks with cut/fill grading of impacted soils during leveling for the cap.	**MODERATE TO GOOD** -Some technical challenges with capping and grading with steep slopes in the canyon. Several vendors available for implementation.	**MODERATE** Capital = $10,565,000 Annual Cost = $364,000/year Present Worth = $16,638,000 (3%, 30-yr) Present Worth = $12,682,000 (7%, 30-yr) Present Worth = $21,915,000	**MODERATE** Green and sustainability impacts based on cut/fill grading of 130,000 cy, borrow soil and compaction of 123,000 cy, construction of larger evaporation pond (+ 3 acres), materials (TRMs) manufacturing and installation, grading/BMPs for

TABLE 11-3
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 2
RCRA CANYON AND WEST CANYON SPRAY AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [3]	Green Impacts Assessment
		and can take precautions.		eliminate the potential for seeps in the RCRA Canyon. -Uncapped areas would be graded with BMPs to minimize erosion. Stormwater from uncapped areas would be directed to the proposed on-site evaporation pond until it can be shown to be clean for off-site discharge under the site's General Permit.	conductivity. Infiltration will be minimal with this cap and GW modeling shows that water table will be significantly lowered and would thus minimize the potential for seeps in the RCRA Canyon.			(3%, 100-yr) Present Worth = $13,500,000 (7%, 100-yr)	19 acres
5	**RCRA-Equivalent Mono Soil Cap (West Slope RCRA Canyon) (5') + Excavate (WCSA Remedial Area) (5') + Clean Soil Cover (Uncapped Area)(2') + Stormwater Controls (Segregate Capped and Uncapped Area SW) + ICs + Monitoring**	**YES** -Would be protective because cap would ensure that there are no exposures to ecological receptors and on-site workers. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE TO GOOD** -Controls potential for long term direct contact exposure to contaminants with a RCRA-equivalent cap and an excavation for the two remedial areas. The cap would meet the performance requirements with respect to hydraulic conductivity and thus minimize infiltration through impacted soils. This along with the drains that collect stormwater would eliminate the potential for seeps in the RCRA Canyon. The backfill of the WCSA excavation will be compacted (10^{-4} to 10^{-6} cm/s) adequately to reduce infiltration. -Uncapped areas would be covered with a 2-foot soil cover that would limit additional leaching of inorganics, protect groundwater and allow stormwater from the uncapped areas to be directed off-site as clean for discharge under the site's General Permit. There is some uncertainty in long term performance of the 2-foot soil cover due to the steep slopes in the east slope of the canyon but cut/fill grading will be used to reduce steep slopes to 2:1.	**POOR** -No reduction in toxicity, mobility and volume as a result of soil treatment but the RCRA-equivalent cap and excavation would significantly reduce mobility of contaminants based on the RCRA-equivalent soil cap that would achieve the $1x10^{-6}$ cm/s performance standard for hydraulic conductivity. The backfill of the WCSA excavation will be compacted (10^{-4} to 10^{-6} cm/s) adequately to reduce infiltration. Minimal infiltration will lower water tables and eliminate potential for seeps in the RCRA Canyon. -Additional 2-foot clean soil cover will minimize potential for contaminant migration via sediments and limit additional leaching of inorganics and protect groundwater.	**MODERATE TO GOOD** -No significant risk because the soil caps would be constructed out of imported clean soils mostly from the off-site NW borrow area. Minor risks with cut/fill grading of impacted soils during leveling for the cap and dust from the excavation.	**MODERATE** -Some technical challenges with capping and grading with steep slopes in the canyon especially in the east slopes of the canyon (almost 1:1). Significant amount of cut/fill grading is assumed to reduce slopes to 2:1. Several vendors available for implementation.	**MODERATE TO HIGH** Capital = $11,423,000 Annual Cost = $395,000/year Present Worth = $18,011,000 (3%, 30-yr) Present Worth = $13,727,000 (7%, 30-yr) Present Worth = $23,736,000 (3%, 100-yr) Present Worth = $14,614,000 (7%, 100-yr)	**MODERATE TO HIGH** Green and sustainability impacts based on cut/fill grading of 400,000 cy, excavation of 44,000 cy, and borrow soil and compaction of 210,000 cy, materials (TRMs) manufacturing and installation and grading and BMPs for 19 acres, and 6,000 feet of drains on cap. No need for larger evaporation pond.

TABLE 11-3
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 2
RCRA CANYON AND WEST CANYON SPRAY AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [3]	Green Impacts Assessment
6	**RCRA- Equivalent Hybrid Cap (West Slope RCRA Canyon) (5') + Excavate (WCSA Remedial Area) + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring**	**YES** **-** Would be protective because cap would ensure that there are no exposures to ecological receptors and on-site workers. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** **-** This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE TO GOOD** **-** Controls potential for long term exposure to contaminants with a RCRA-equivalent cap using a geosynthetic liner and an excavation for the two remedial areas. The cap would meet the performance requirements with respect to hydraulic conductivity and thus minimize infiltration through impacted soils. This along with the drains that collect stormwater would eliminate the potential for seeps in the RCRA Canyon. -Uncapped areas would be covered with a 2-foot soil cover that would limit additional leaching of inorganics, protect groundwater and allow stormwater from the uncapped areas to be directed off-site as clean for discharge under the site's General Permit. There is some uncertainty in long term performance of the 2-foot soil cover due to the steep slopes in the east slope of the canyon but cut/fill grading will be used to reduce steep slopes to 2:1.	**POOR** **-** No reduction in toxicity, mobility and volume as a result of soil treatment but mobility is significantly reduced based on the excavation and the RCRA equivalent soil cap that would achieve the $1x10^{-6}$ cm/s performance standard for hydraulic conductivity. Reduced infiltration will significantly lower the water table and minimize the potential for seeps in the RCRA Canyon.	**MODERATE TO GOOD** **-** No significant risk because the soil caps would be constructed out of imported clean soils mostly from the off-site NW borrow area. Minor risks with cut/fill grading of impacted soils during leveling for the cap and dust from the excavation.	**MODERATE** **-** Some technical challenges with capping and grading with steep slopes in the remedial areas of the canyon. Significant amount of cut/fill grading is assumed to reduce slopes to 2:1 or lower slope due to potential slip failure of geosynthetic membrane over time. Several vendors available for implementation.	**MODERATE TO HIGH** Capital = $11,772,000 Annual Cost = $411,000/year Present Worth = $18,627,000 (3%, 30-yr) Present Worth = $14,187,000 (7%, 30-yr) Present Worth = $24,568,000 (3%, 100-yr) Present Worth = $15,108,000 (7%, 100-yr)	**MODERATE TO HIGH** Green and sustainability impacts based on cut/fill grading of 400,000 cy, borrow soil and compaction of 140,000 cy, materials (HDPE liner, biotic barrier, geocomposite drainage layer) for 8.4 acres, jute mesh and TRMs for 5.5 acres, manufacturing and installation, grading/BMPs for 19 acres, and 6,000 feet of drains on cap. No need for larger evaporation pond.
7	**Evapotranspirative (ET) Cap (West Slope RCRA Canyon) (5') + Excavate (WCSA Remedial Area) + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring**	**YES** **-**Would be protective because cap would ensure that there are no exposures to ecological receptors and on-site workers. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** **-**This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE TO GOOD** **-**Controls potential for long term exposure to contaminants with an ET cap and an excavation for the two remedial areas. The cap would meet the performance requirements with respect to hydraulic conductivity and thus minimize infiltration through impacted soils. This along with the drains that collect stormwater would eliminate the potential for seeps in the RCRA Canyon. -Uncapped areas would be covered with a 2-foot soil cover that would limit additional leaching of inorganics, protect groundwater and allow stormwater from the uncapped areas to be directed off-site as clean for discharge under the site's General Permit. There is some uncertainty in long term performance of the 2-foot soil cover due to the steep slopes in the east slope of the canyon but cut/fill grading will be used to reduce steep slopes to 2:1.	**POOR** **-**No reduction in toxicity, mobility and volume as a result of soil treatment but mobility is significantly reduced based on the excavation and the ET soil cap. Reduced infiltration will significantly lower the water table and minimize the potential for seeps in the RCRA Canyon.	**MODERATE TO GOOD** **-**No significant risk because the soil caps would be constructed out of imported clean soils mostly from the off-site NW borrow area. Minor risks with cut/fill grading of impacted soils during leveling for the cap and dust from the excavation.	**MODERATE** **-**Some technical challenges with capping and grading with steep slopes in the remedial areas of the canyon. Significant amount of cut/fill grading is assumed to reduce slopes to 2:1 but considered better with respect to potential for slip failure than a geosynthetic membrane. Several vendors available for implementation.	**MODERATE TO HIGH** Capital = $11,116,000 Annual Cost = $395,000/year Present Worth = $17,738,000 (3%, 30-yr) Present Worth = $13,491,000 (7%, 30-yr) Present Worth = $23,436,000 (3%, 100-yr) Present Worth = $14,374,000 (7%, 100-yr)	**MODERATE TO HIGH** Green and sustainability impacts based on cut/fill grading of 400,000 cy, excavation of 44,000 cy, and borrow soil and compaction of 210,000 cy, materials (TRMs) manufacturing and installation and grading and BMPs for 19 acres, and 6,000 feet of drains on cap. No need for larger evaporation pond.

TABLE 11-3
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 2
RCRA CANYON AND WEST CANYON SPRAY AREA
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost [3]	Green Impacts Assessment
8	**RCRA- Equivalent Hybrid Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because cap would ensure that there are no exposures to ecological receptors and on-site workers. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**GOOD** -Controls potential for long term direct contact exposure to contaminants with a RCRA-equivalent cap with a geosynthetic liner for the entire RCRA Canyon and WCSA. The cap would meet the performance requirements with respect to hydraulic conductivity and thus minimize infiltration through impacted soils. However, there is some uncertainty in the long term effectiveness of the spiked HDPE liner in steep slopes (e.g. 2:1 or greater) and its potential for slip failure. -This cap along with the drains that collect stormwater would eliminate the potential for seeps in the RCRA Canyon. Stormwater from the uncapped areas would be directed off-site as clean for discharge under the site's General Permit.	**POOR** -No reduction in toxicity, mobility and volume as a result of soil treatment but the RCRA-equivalent cap would significantly reduce mobility of contaminants based on the RCRA-equivalent soil cap that would achieve the $1x10^{-6}$ cm/s performance standard for hydraulic conductivity. Preventing infiltration will lower water tables and minimize potential for seeps in the RCRA Canyon.	**MODERATE TO GOOD** -No significant risk because the soil caps would be constructed out of imported clean soils mostly from the off-site NW borrow area. Minor risks with cut/fill grading of impacted soils during leveling for the cap.	**MODERATE** -Significantly larger volume of cut/fill grading required with the steeper slopes in the east slope of the canyon (almost 1:1). Moderate technical challenges with capping and grading with steep slopes in the canyon and reliability concerns with potential for slip failure. Several vendors available for implementation.	**HIGH** Capital = $16,675,000 Annual Cost = $489,000/year Present Worth = $24,513,000 (3%, 30-yr) Present Worth = $18,911,000 (7%, 30-yr) Present Worth = $31,808,000 (3%, 100-yr) Present Worth = $20,042,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts based on cut/fill grading of 400,000 cy, and borrow soil and compaction of 120,000 cy, materials (HDPE liner, biotic barrier, geocomposite drainage layer) for 33 acres, 16,000 feet of drains on cap. No need for larger evaporation pond.
9	**Evapotranspirative (ET) Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because cap would ensure that there are no exposures to ecological receptors and on-site workers. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**GOOD** -Controls potential for long term direct contact exposure to contaminants with an ET cap for the entire RCRA Canyon and WCSA. The cap would meet the performance requirements with respect to hydraulic conductivity and thus minimize infiltration through impacted soils. -This cap along with the drains that collect stormwater would eliminate the potential for seeps in the RCRA Canyon. Stormwater from the uncapped areas would be directed off-site as clean for discharge under the site's General Permit.	**POOR** -No reduction in toxicity, mobility and volume as a result of soil treatment but the ET cap would significantly reduce mobility of contaminants. Preventing infiltration will lower water tables and minimize potential for seeps in the RCRA Canyon.	**MODERATE TO GOOD** -No significant risk because the soil caps would be constructed out of imported clean soils mostly from the off-site NW borrow area. Minor risks with cut/fill grading of impacted soils during leveling for the cap.	**MODERATE** -Significantly larger volume of cut/fill grading required with the steeper slopes in the east slope of the canyon (almost 1:1). Moderate technical challenges with capping and grading with steep slopes in the canyon and reliability concerns with potential for slip failure. Several vendors available for implementation.	**HIGH** Capital = $15,655,000 Annual Cost = $473,000/year Present Worth = $23,301,000 (3%, 30-yr) Present Worth = $17,936,000 (7%, 30-yr) Present Worth = $30,322,000 (3%, 100-yr) Present Worth = $19,024,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts based on cut/fill grading of 400,000 cy, borrow soil and compaction of 300,000 cy, materials (HDPE liner, geocomposite drainage layer) for 33 acres, (jute mesh, TRMs) manufacturing and installation, and 16,000 feet of drains on cap.

TABLE NOTES

1. Ratings for the threshold criteria are provided as "Yes" or "No". For example, "Yes" would indicate the alternative provides adequate protection of health and environment or that the alternative is in compliance with ARARs.
2. Ratings for the five balancing criteria are provided on a rating scale from a range of low rating (poor) to highest rating (good) for each criterion. For the cost criterion, the ratings vary from low to very high.
3. Detailed cost estimate sheets are provided in Appendix E. The present worth costs are presented in 2014$ for a 30-year and 100-year timeframe with 3% and 7% net discount rates. Costs are approximate (+50%/-30%) and include a contingency of 35 to 50%.
4. Engineering controls for storm water refers to V-drains, erosion controls, etc. It is included for all active remedial alternatives and is intended to control potential contaminant migration through storm water.
5. The stormwater plan will involve drainage of capped flows through a drainage channel to the lined retention basin in Pond A-5 footprint and then transfer through a pipeline that flows through the footprint of the RCF pond and then discharged through the wetlands into the B-drainage under the site's General Permit. Stormwater flows from areas that do not meet the General Permit requirements would be conveyed to the on-site evaporation pond.
6. Green impacts assessment is a qualitative rating of environmental impacts (footprint) based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative. The higher the rating, the greater the impacts and hence, the less green the alternative.

TABLE 11-4
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 3
FORMER PADS AND PONDS SUBAREA, ROADWAYS AND REMAINING ON-SITE AREAS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost	Green Impacts Assessment
1	**No Action**	**NO** -Would not be protective because it does not include any remediation or long term controls, and future owners or construction workers could encounter contamination.	**NO** -This alternative would not meet the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NONE**	**NONE**
2	**RCRA Cap (Locations 2, 3, 4) + Excavate/New Asphalt Cap (Location 1) (5') + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because capping and engineering controls would ensure that there are no exposures to on-siteon-site workers or to ecological receptors. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE TO GOOD** -Controls potential for long term exposure to contaminants at Locations 2, 3 and 4 with a RCRA cap and at Location 1 with excavation. Residual risk will meet RAOs (LOAEL HQ<1) because each location is excavated down to 5 feet bgs. Furthermore, migration of VOCs and metals in soil and groundwater will be significantly reduced with the RCRA cap. Groundwater monitoring at Location 10 would provide notification if this impacted soil poses a threat to groundwater.	**POOR** -No reduction in toxicity and volume but mobility is significantly reduced based on the RCRA cap that would minimize leachate production or contaminant migration. Migration of VOCs and metals in soil and groundwater will be significantly reduced with the elimination of recharge with cap extensions.	**GOOD** -No significant risk because the RCRA cap would be constructed out of clean soils without excavating contaminated soils.	**MODERATE TO GOOD** - No significant challenges with extension of RCRA caps in these areas except for minor challenges with some locations with steep slopes. Several vendors available for implementation.	**MODERATE TO HIGH** Capital = $5,909,000 Annual Cost = $258,000/year Present Worth = $10,423,000 (3%, 30-yr) Present Worth = $7,801,000 (7%, 30-yr) Present Worth = $14,030,000 (3%, 100-yr) Present Worth = $8,360,000 (7%, 100-yr)	**MODERATE** Green and sustainability impacts are based on cut/fill grading of 60,000 cy and borrow soil/compaction for caps of 48,000 cy, excavation of 8,000 cy, materials manufacture, transport, installation (6.6 acres HDPE, GCL liner). Assume use of on-siteon-site water in ponds minimizes use of other clean water supplies.
3	**RCRA Cap (Location 2) + Excavate ((Location 3) (20'); (Location 4) (5')) + Excavate/New Asphalt Cap (Location 1) (5') + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because capping and engineering controls would ensure that there are no exposures to on-siteon-site workers or to ecological receptors. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE TO GOOD** -Controls potential for long term exposure to contaminants at Location 2 with a RCRA cap and at Locations 1, 3, and 4 with excavation. Residual risk will meet RAOs (LOAEL HQ<1) because each location is excavated down to at least 5 feet bgs. Removes source areas in soil at Location 3, and migration of VOCs and metals in soil and groundwater will be significantly reduced with the RCRA cap at Location 2. Groundwater monitoring at Location 10 would provide notification if this impacted soil poses a threat to groundwater.	**POOR TO MODERATE** -There is reduction in toxicity, mobility and volume due to contaminant excavation in soil but soil is not treated. Mobility is significantly reduced at Location 2 based on the RCRA cap that would minimize leachate production or contaminant migration. Migration of VOCs and metals in soil and groundwater will be significantly reduced with the elimination of recharge with cap extensions.	**MODERATE TO GOOD** -No significant risk because the RCRA cap at Location 2 would be constructed out of clean soils. Moderate potential for emissions of COCs emissions during excavation including VOCs and inorganics (barium, copper) at Location 3 and metals at other locations.	**MODERATE TO GOOD** -No significant challenges with extension of RCRA cap at Location 2, or with excavations at Locations 1 or 4. Some technical challenges with deep soil excavation at Location 3 (Ponds A/B). Several vendors available for implementation.	**MODERATE TO HIGH** Capital = $6,681,000 Annual Cost = $196,000/year Present Worth = $9,888,000 (3%, 30-yr) Present Worth = $7,619,000 (7%, 30-yr) Present Worth = $12,814,000 (3%, 100-yr) Present Worth = $8,072,000 (7%, 100-yr)	**MODERATE** Green and sustainability impacts are based on cut/fill grading of 17,000 cy and borrow soil/compaction for caps of 20,000 cy, excavation of 92,000 cy, materials manufacture, transport, installation (2.8 acres HDPE, GCL liner). Assume use of on-siteon-site water in ponds minimizes use of other clean water supplies.

TABLE 11-4
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 3
FORMER PADS AND PONDS SUBAREA, ROADWAYS AND REMAINING ON-SITE AREAS
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost	Green Impacts Assessment
4	**RCRA Cap (Location 2) + Excavate ((Location 3) (20'); (Location 4) (5'); (Location 10) (50'))/Place in PCB Landfill/Backfill + Excavate/New Asphalt Cap (Location 1) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because capping and engineering controls would ensure that there are no exposures to on-site workers or to ecological receptors. ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE TO GOOD** -Controls potential for long term exposure to contaminants at Location 2 with a RCRA cap and at Locations 1, 3, 4, and 10 with excavation. Residual risk will meet RAOs (LOAEL HQ<1) because each location is excavated down to at least 5 feet bgs. Removes source areas in soil at Locations 3 and 10, and migration of VOCs and metals in soil and groundwater will be significantly reduced with the RCRA cap at Location 2.	**POOR TO MODERATE** -There is reduction in toxicity, mobility and volume due to contaminant excavation in soil but soil is not treated. Mobility is significantly reduced at Location 2 based on the RCRA cap that would minimize leachate production or contaminant migration. But mobility would still be a concern due to surface water infiltration through soil backfill/cap that can cause contaminant in deep soil and groundwater to migrate.	**MODERATE** -Moderate potential for emissions of COCs emissions during excavation including PAHs at RISBON-59, VOCs and inorganics (barium, copper) at Location 3 and metals at other locations.	**MODERATE** -Some technical challenges with deep soil excavation at Location 10 (RISBON-59) and Location 3 (Ponds A/B). Soils at RISBON-59 location are also part of the berm to the RCF pond which could pose a problem if RCF Pond levels are high. Several vendors available for implementation.	**MODERATE TO HIGH** Capital = $8,368,000 Annual Cost = $196,000/year Present Worth = $11,389,000 (3%, 30-yr) Present Worth = $8,912,000 (7%, 30-yr) Present Worth = $14,460,000 (3%, 100-yr) Present Worth = $9,388,000 (7%, 100-yr)	**MODERATE TO HIGH** Green and sustainability impacts are based on cut/fill grading of 17,000 cy and borrow soil/compaction for caps of 20,000 cy, excavation of 157,000 cy, materials manufacture, transport, installation (2.8 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.
5	**Excavate ((Locations 2, 4) (5'); (Location 3)(20'); (Location 10) (50')) + Dispose Soils at Off-siteOff-site Landfill/Backfill/Clean Soil Cap + Excavate/Asphalt Cap (Location 1)(5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because excavation and soil capping would ensure that there are no exposures to on-site workers or to ecological receptors. ICs would ensure that future property owners and on-site workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including RCRA if hazardous wastes are encountered, requirements for a worker health and safety program, and the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**MODERATE** – Controls potential for long term exposure to contaminants at Locations 1, 2, 3, 4, and 10 with excavation. Residual risk will meet RAOs because it eliminates contaminants by excavation. Potential exposure and risk concerns at off-site locations with transportation and disposal of wastes at TSDF.	**POOR TO MODERATE** -There is reduction in toxicity, mobility and volume due to contaminant excavation in shallow soil but soil is not treated. But mobility would still be a concern due to surface water infiltration through soil backfill/cap that can cause contaminant in deep soil and groundwater to migrate.	**MODERATE** -Moderate potential for emissions of COCs emissions during excavation including PAHs at RISBON-59, VOCs and inorganics (barium, copper) at Location 3 and metals at other locations.	**MODERATE** -Some technical challenges with deep soil excavation at Location 10 (RISBON-59) and Location 3 (Ponds A/B). Soils at RISBON-59 location are also part of the berm to the RCF pond which could pose a problem if RCF Pond levels are high. Several vendors available for implementation.	**HIGH** Capital = $25,564,000 Annual Cost = $97,000/year Present Worth = $24,727,000 (3%) Present Worth = $20,854,000 (7%) Present Worth = $25,885,000 (3%) Present Worth = $21,034,000 (7%)	**HIGH** Green and sustainability impacts are based on excavation of 200,000 cy and backfill borrow soil/compaction for caps of 220,000 cy, transport 190,000 tons of soils about 120 miles to Buttonwillow. Assume use of on-site water in ponds minimizes use of other clean water supplies.

TABLE NOTES

1. Ratings for the threshold criteria are provided as "Yes" or "No". For example, "Yes" would indicate the alternative provides adequate protection of health and environment or that the alternative is in compliance with ARARs.
2. Ratings for the balancing criteria are provided on a rating scale from a range of low rating (poor) to highest rating (good) for each criterion. For the cost criterion, the ratings vary from low to very high.
3. Detailed cost estimate sheets are provided in Appendix E. The present worth costs are presented in 2014$ for a 30-year timeframe with a 3% and 7% discount rate as indicated in parentheses. Costs are approximate (+50%/-30%) and include a contingency of 50%.
4. Storm water controls refers to V-drains, erosion controls, etc. It is included for all active remedial alternatives and is intended to control potential contaminant migration through storm water.
5. Green impacts assessment is a qualitative rating of environmental impacts (footprint) based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative. The higher the rating, the greater the impacts and hence, the less green the alternative.

TABLE 11-5
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 4
STORMWATER PONDS AND TREATED LIQUID IMPOUNDMENTS (RCF, A-SERIES, A-5, 13, 18 PONDS)
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost	Green Impacts Assessment
1	**No Action**	**NO** -Would not be protective because it does not include any remediation or long term controls and future owners or construction workers could encounter contamination.	**NO** -This alternative would not meet the pond closure requirements and the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NONE**	**NONE**
2	**Ecological-Cap (RCF, A-Series Pond) (2') + Construct New 11-Acre Evaporation Pond + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs+ Monitoring**	**YES** -Would be protective because eliminating pond liquids and capping would ensure that there are no exposures to on-site workers or to ecological receptors. RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur. -ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. Will be in compliance with requirements for pond closures.	**MODERATE** -Controls potential for long term exposure to contaminants for ecological receptors. No residual ecological-risk because it includes long term cap maintenance and monitoring. -RCF and A-Series Pond bottoms are raised to above the future anticipated water table and thus avoid groundwater intrusion into the pond. -Infiltration of surface water into groundwater would occur with the 2-foot thick ecological cap at the RCF and the A-Series Pond. However infiltration would be reduced because the capped surface is sloped and the stormwater is directed off-site through drains and not stored in ponds. -Surface water infiltration will be eliminated in Pond 18 with the RCRA cap and Ponds A-5 and 13 which are lined stormwater retention basins.	**POOR** -No reduction in toxicity and volume through treatment. -Removal of pond liquids and capping of sediments will reduce potential for exposure for ecological receptors and reduce mobility of metals from sediments into groundwater.	**MODERATE** -Concerns with protection of ecological species with the larger 11-acre evaporation pond -No significant risk with cap construction because the impacted sediments would be covered with an ecological cap or RCRA cap using clean imported soils. Limited excavation of sediments as part of cut/fill grading prior to capping. - Significant excavation volume expected with construction of new lined evaporation pond north of the RCF.	**MODERATE** - Challenges with implementation of netting and drift fences to protect special status species with a larger 11-acre evaporation pond -Minor technical challenges with capping deepest part of pond bottoms and steep side slopes of the RCF and A-Series Ponds. Difficulties with excavation equipment in muddy pond bottoms. Several vendors available for implementation.	**HIGH** Capital = $18,272,000 Annual Cost = $458,000/year Present Worth = $29,436,000 (3%, 30-yr) Present Worth = $22,217,000 (7%, 30-yr) Present Worth = $41,378,000 (3%, 100-yr) Present Worth = $24, 068,000 (7%, 100-yr)	**MODERATE TO HIGH** -Green and sustainability impacts are based on cut/fill grading or excavation of 120,000 cy and borrow soil/compaction for caps of 350,000 cy, materials manufacture, transport, installation (55 acres HDPE, GCL liner). Assume use of remaining pond water minimizes use of other clean water supplies.
3	**Ecological-Cap (RCF Pond, Segregate East RCF) (2') + Construct Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because eliminating pond liquids and capping would ensure that there are no exposures to on-site workers or to ecological receptors. RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur. -ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. Will be in compliance with requirements for pond closures.	**MODERATE TO GOOD** -Controls potential for long term exposure to contaminants for ecological receptors. No residual ecological-risk because it includes long term cap maintenance and monitoring. -RCF West and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion into the pond. Segregated RCF East serves as a contingency plan if groundwater rises unexpectedly. RCF Pond is essentially an evaporation pond for any stormwater that collects in it and would allow any groundwater to evaporate.	**POOR** -No significant reduction in toxicity and volume through treatment. -Removal of pond liquids and capping of sediments will reduce potential for exposure for ecological receptors and reduce mobility of metals from sediments into groundwater. -Potential for impacts on surface water quality from groundwater intrusion is minimized by the segregation of the East RCF Pond.	**MODERATE** -Concerns with protection of ecological species with the larger 11-acre evaporation pond -No significant risk because the impacted sediments would be covered with an ecological cap or RCRA cap using clean imported soils. -Limited excavation of sediments from A-Series and RCF Ponds as part of cut/fill grading prior to capping and excavation of the NE shoreline is not considered a significant potential exposure or risk.	**MODERATE** -Challenges with implementation of netting and drift fences to protect special status species with a larger 11-acre evaporation pond and the segregated West RCF Pond -Minor technical challenges with capping deepest part of pond bottoms and steep side slopes of the RCF and A-Series Ponds. Difficulties with excavation equipment in muddy pond bottoms. Several vendors available for implementation.	**MODERATE** Capital = $13,739,000 Annual Cost = $458,000/year Present Worth = $25,447,000 (3%, 30-yr) Present Worth = $18,771,000 (7%, 30-yr) Present Worth = $36,631,000 (3%, 100-yr) Present Worth = $20,505,000 (7%, 100-yr)	**MODERATE** -Green and sustainability impacts are based on cut/fill grading or excavation of 43,000 cy and borrow soil/compaction for caps of 275,000 cy, materials manufacture, transport, installation (45 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.

TABLE 11-5
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 4
STORMWATER PONDS AND TREATED LIQUID IMPOUNDMENTS (RCF, A-SERIES, A-5, 13, 18 PONDS)
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost	Green Impacts Assessment
				-Surface water infiltration would occur in the RCF Pond but is expected to be reduced because stormwater is directed by the sheet flow over the sloped cap and drains off-site. Surface water infiltration will be eliminated in the A-Series Pond, Pond 18 and Ponds A-5 and 13 which are lined or have a RCRA cap.					
4	**Ecological-Cap (RCF Pond) (2') + Construct 11-Acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because eliminating pond liquids and capping would ensure that there are no exposures to on-site workers or to ecological receptors. RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur. -ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. Will be in compliance with requirements for pond closures.	**MODERATE TO GOOD** -Controls potential for long term exposure to contaminants for ecological receptors. No residual ecological-risk because it includes long term cap maintenance and monitoring. -RCF West and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur with the 2-foot thick ecological cap at the RCF Pond. However infiltration would be reduced because the capped surface is sloped and the stormwater is directed off-site through drains and not stored in ponds. -Surface water infiltration will be eliminated in Pond 18 with the RCRA cap and Ponds A-5, 13, and the A-Series Pond which are lined stormwater retention basins.	**POOR** -No significant reduction in toxicity and volume through treatment -Removal of pond liquids and capping of sediments will significantly reduce potential for exposure for ecological receptors and reduce mobility of metals from sediments into groundwater. .	**MODERATE** -Concerns with protection of ecological species with the larger 11-acre evaporation pond -No significant risk because the impacted sediments would be covered with an ecological cap or RCRA cap using clean imported soils. -Limited excavation of sediments as part of cut/fill grading prior to capping.	**MODERATE** -Challenges with implementation of netting and drift fences to protect special status species with a larger 11-acre evaporation pond -Minor technical challenges with capping deepest part of pond bottoms and steep side slopes of the RCF and A-Series Ponds. Difficulties with excavation equipment in muddy pond bottoms. Several vendors available for implementation.	**MODERATE** Capital = $14,092,000 Annual Cost = $458,000/year Present Worth = $25,761,000 (3%, 30-yr) Present Worth = $19,042,000 (7%, 30-yr) Present Worth = $37,005,000 (3%, 100-yr) Present Worth = $20,785,000 (7%, 100-yr)	**MODERATE** -Green and sustainability impacts are based on cut/fill grading or excavation of 56,000 cy and borrow soil/compaction for caps of 300,000 cy, materials manufacture, transport, installation (45 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.
5	**Ecological-Cap (RCF Pond, Portion of A-Series Pond) + Construct 6-Acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because eliminating pond liquids and capping would ensure that there are no exposures to on-site workers or to ecological receptors. RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur. -ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** – This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. Will be in compliance with requirements for pond closures.	**MODERATE TO GOOD** -Controls potential for long term exposure to contaminants for ecological receptors. No residual ecological-risk because it includes long term cap maintenance and monitoring. -RCF and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion into the pond. -While infiltration of surface water will occur with the ecological-cap on the RCF and portion of A-Series; however, infiltration would be significantly reduced because the capped surface is sloped and the stormwater is directed off-site through drains.	**POOR** -No significant reduction in toxicity and volume through treatment. -Removal of pond liquids and capping of sediments will significantly reduce potential for exposure for ecological receptors and reduce mobility of metals from sediments into groundwater.	**MODERATE TO GOOD** -No significant concerns with protection of ecological species with smaller 6-acre evaporation pond constructed as six 1-acre pond cells -No significant risk because the impacted sediments would be covered with an ecological cap or RCRA cap using clean imported soils. Limited excavation of sediments as part of cut/fill grading prior to capping.	**MODERATE TO GOOD** -No significant challenges with implementation of netting and drift fences to protect special status species with a smaller 6-acre evaporation pond -Minor technical challenges with capping deepest part of pond bottoms and steep side slopes of the RCF and A-Series Ponds. Difficulties with excavation equipment in muddy pond bottoms. Several vendors available for implementation.	**MODERATE** Capital = $13,131,000 Annual Cost = $386,000/year Present Worth = $21,621,000 (3%, 30-yr) Present Worth = $16,287,000 (7%, 30-yr) Present Worth = $30,318,000 (3%, 100-yr) Present Worth = $17,636,000 (7%, 100-yr)	**MODERATE** -Green and sustainability impacts are based on cut/fill grading or excavation of 56,000 cy and borrow soil/compaction for caps of 250,000 cy, materials manufacture, transport, installation (34 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.

TABLE 11-5
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 4
STORMWATER PONDS AND TREATED LIQUID IMPOUNDMENTS (RCF, A-SERIES, A-5, 13, 18 PONDS)
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost	Green Impacts Assessment
				-Surface water infiltration will be eliminated in Pond 18 with the RCRA cap and Ponds A-5, 13, and portions of the A-Series Pond which are lined stormwater retention basins.					
6	**Ecological-Cap (RCF Pond, A-Series Pond) (2') + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring** **[No evaporation pond]**	**YES** -Would be protective because eliminating pond liquids and capping would ensure that there are no exposures to on-site workers or to ecological receptors. RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur. -ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. Will be in compliance with requirements for pond closures.	**MODERATE TO GOOD** -Controls potential for long term exposure to contaminants for ecological receptors. No residual ecological-risk because it includes long term cap maintenance and monitoring. -RCF and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur with the 2-foot thick ecological cap but would be significantly reduced because the capped surface is sloped and the stormwater is directed off-site through drains and not stored in ponds. -Surface water infiltration will be eliminated in Pond 18 with the RCRA cap and Ponds A-5 and 13, which are lined stormwater retention basins.	**POOR** -No significant reduction in toxicity and volume through treatment. -Removal of pond liquids and capping of sediments will significantly reduce potential for exposure for ecological receptors and reduce mobility of metals from sediments into groundwater.	**MODERATE TO GOOD** -No concerns with protection of ecological species because there is no evaporation pond -No significant risk because the impacted sediments would be covered with an ecological cap or RCRA cap using clean imported soils. Limited excavation of sediments as part of cut/fill grading prior to capping.	**MODERATE TO GOOD** -No evaporation pond with this alternative -Challenges with implementation of netting and drift fences to protect special status species with a larger 11-acre evaporation pond -Minor technical challenges with capping deepest part of pond bottoms and steep side slopes of the RCF and A-Series Ponds. Difficulties with excavation equipment in muddy pond bottoms. Several vendors available for implementation.	**MODERATE** Capital = $10,590,000 Annual Cost = $255,000/year Present Worth = $14,524,000 (3%, 30-yr) Present Worth = $11,349,000 (7%, 30-yr) Present Worth = $19,403,000 (3%, 100-yr) Present Worth = $12,105,000 (7%, 100-yr)	**MODERATE** -Green and sustainability impacts are based on cut/fill grading or excavation of 56,000 cy and borrow soil/compaction for caps of 350,000 cy, materials manufacture, transport, installation (34 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.
7	**ET Cap (RCF Pond, Portion of A-Series Pond) + Construct 6-Acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because eliminating pond liquids and capping would ensure that there are no exposures to on-site workers or to ecological receptors. RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur. -ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. Will be in compliance with requirements for pond closures.	**MODERATE TO GOOD** -Controls potential for long term exposure to contaminants for ecological receptors. No residual ecological-risk because it includes long term cap maintenance and monitoring. -RCF and A-Series Pond bottoms are raised above the future anticipated water table and thus avoid groundwater intrusion into the pond. -While infiltration of surface water will occur with the ecological-cap on the RCF and portion of A-Series; however, infiltration would be significantly reduced because the capped surface is sloped and the stormwater is directed off-site through drains. -Surface water infiltration will be eliminated in Pond 18 with the RCRA cap and Ponds A-5, 13, and portions of the A-Series Pond which are lined stormwater retention	**POOR** -No significant reduction in toxicity and volume through treatment. -Removal of pond liquids and capping of sediments will significantly reduce potential for exposure for ecological receptors and reduce mobility of metals from sediments into groundwater.	**MODERATE TO GOOD** -No significant concerns with protection of ecological species with smaller 6-acre evaporation pond constructed as six 1-acre pond cells -No significant risk because the impacted sediments would be covered with an ET cap or RCRA cap using clean imported soils. Limited excavation of sediments as part of cut/fill grading prior to capping.	**MODERATE TO GOOD** -No significant challenges with implementation of netting and drift fences to protect special status species with a smaller 6-acre evaporation pond -Minor technical challenges with capping deepest part of pond bottoms and steep side slopes of the RCF and A-Series Ponds. Difficulties with excavation equipment in muddy pond bottoms. Several vendors available for implementation.	**MODERATE TO HIGH** Capital = $15,658,000 Annual Cost = $386,000/year Present Worth = $23,869,000 (3%, 30-yr) Present Worth = $18,225,000 (7%, 30-yr) Present Worth = $32,999,000 (3%, 100-yr) Present Worth = $19,640,000 (7%, 100-yr)	**MODERATE TO HIGH** -Green and sustainability impacts are based on cut/fill grading or excavation of 56,000 cy and borrow soil/compaction for caps of 400,000 cy, materials manufacture, transport, installation (34 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.

TABLE 11-5
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 4
STORMWATER PONDS AND TREATED LIQUID IMPOUNDMENTS (RCF, A-SERIES, A-5, 13, 18 PONDS)
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness	Implementability	Cost	Green Impacts Assessment
				basins.					
8	**Excavate/Clean Backfill (RCF Pond, A-Series Pond) (5') + Construct New 11-Acre Lined Evaporation Pond (North of RCF Pond) + RCRA Cap (Pond 18) + Lined Retention Basins (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring**	**YES** -Would be protective because pumping of liquids and excavating sediments would ensure that there are no exposures to on-site workers or to ecological receptors. -ICs would ensure that future property owners and construction workers are aware that they may encounter contamination and can take precautions.	**YES** -This alternative would be in compliance with ARARs, including the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels. Will be in compliance with requirements for pond closures.	**MODERATE** -Excavates sediments and backfills with clean soil cover and controls potential for long term exposure to contaminants for ecological receptors. No residual ecological risk because it includes long term cap maintenance and monitoring. -RCF and A-Series Pond bottoms are raised and expected to be above the water table and avoid groundwater intrusion into the pond. Infiltration of surface water into groundwater would occur. -Rainwater infiltration will be significantly reduced with the sloped cap on the bottom of the ponds and drains to direct stormwater off-site through the B Drainage. No contingency is included in the event of unexpected rise in the water table and potential concerns with impacting quality of stormwater discharge.	**POOR TO MODERATE** Removal of liquids and excavation of sediments will reduce toxicity and mobility and volume of contaminants at this area. However, this alternative gets only a limited credit for reduction of toxicity, mobility and volume because contaminants are transported off-site to a permitted landfill (e.g. Buttonwillow or Kettleman) as non-RCRA hazardous waste disposal and is not treated.	**POOR TO MODERATE** -Significant volume of excavation (93,000 cy) of sediments up to 5 feet deep can cause potential emissions as dust and pose on-site worker risk. Potential risks from transportation of 140,000 tons of impacted soil. -Concerns with protection of ecological species with the larger 11-acre evaporation pond -Significant excavation volume expected with construction of new lined evaporation pond north of the RCF but excavated soil is not expected to be impacted and hence pose no significant risk.	**MODERATE** -Moderate technical challenges with excavation of the pond bottoms and backfill compaction. Difficulties with excavation equipment in muddy pond bottoms. Several vendors available for implementation.	**HIGH** Capital = $40,759,000 Annual Cost = $411,000 /year Present Worth = $48,520,000 (3%, 30-yr) Present Worth = $38,878,000 (7%, 30-yr) Present Worth = $58,495,000 (3%, 100-yr) Present Worth = $40,424,000 (7%, 100-yr)	**HIGH** -Green and sustainability impacts are based on excavation of 170,000 cy and backfill borrow soil/compaction for caps of 300,000 cy, transport 140,000 tons of soils about 120 miles to Buttonwillow, materials manufacture, transport, installation (45 acres HDPE, GCL liner). Assume use of on-site water in ponds minimizes use of other clean water supplies.

TABLE NOTES

1. Ratings for the threshold criteria are provided as "Yes" or "No". For example, "Yes" would indicate the alternative provides adequate protection of health and environment or that the alternative is in compliance with ARARs.
2. Ratings for the five balancing criteria are provided on a rating scale from a range of low rating (poor) to highest rating (good) for each criterion.
3. Stormwater controls refer to V-drains, drainage channels, erosion controls, silt fences, rip rap, etc. to transfer storm water quickly out of the impacted areas of the site and minimize erosion. It is included for all active remedial alternatives and is intended to control potential contaminant migration through storm water.
4. The stormwater plan involves directing clean water from the capped Area 1 through the concrete drainage channel south of the PSCT, the capped flows from Area 2 (RCRA Canyon), and the capped flows from the Area 4 closed ponds being discharged through Pond 13 retention basin in Pond 13 footprint and then discharged through the wetlands into the B-drainage under the site's General NPDES permit. Stormwater flows from areas that do not meet the General permit requirements would be conveyed to the on-site evaporation pond.
5. Green impacts assessment is a qualitative rating of environmental impacts (footprint) based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative. The higher the rating, the greater the impacts and hence, the less green the alternative.

TABLE 11-6A
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 NORTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
1	**No Action**	**NO** -Would not be protective because it does not include any remediation or long term controls and future owners or construction workers could encounter contamination.	**NO** -This alternative would not meet the pond closure requirements and the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NONE**	**NONE**
2	**Extraction (PSCT, Gallery Well) + Treat and Discharge PSCT Groundwater to On-site Evaporation Pond + ICs + Monitoring**	**YES** -This alternative would be protective of human health and environment. -This remedy continues the existing remedial features and will contain the source indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. -ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North, There are no chemical-specific groundwater ARARs for this area because this would be within the TI waiver zone. -Will be in compliance with action-specific ARARs relating to water treatment and vapor control from NAPL storage tanks. -Will be in compliance with ARARs relating to protecting sensitive ecological species from high TDS water in the evaporation pond. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**POOR TO MODERATE** -Would address the RAOs of containing or controlling on-site sources but does not directly address NAPL under P/S Landfill. LNAPL is already effectively contained within the existing site containment features but would be monitored to ensure no migration beyond the PSCT. NAPL under the P/S Landfill is addressed indirectly as the Gallery Well extraction liquids slowly removed NAPL and aqueous phase liquids over the long term as the P/S Landfill is dewatered. -Would address the RAO of containing VOC and inorganics sources with the existing remedial features and anticipated capping for BTA, CDA and PCB Landfill s as part of the soil remedy. -COC mass reduction by extraction is modest though natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -Aquifer restoration would still take hundreds of years. Rationale for technical impracticability of remediating Area 5 North groundwater to applicable standards is presented in Appendix A. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**POOR** -Only minor reduction in toxicity, mobility and volume is expected with this alternative that includes source control with PSCT and Gallery well extraction. About 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year that decreases with time as the P/S Landfill is dewatered. About 1.9 million gallons of PSCT groundwater treated per year. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. -Natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**GOOD** -No significant risk to human health (on-site workers or community) or environment during operation. -This treatment system is already operating at the site.	**GOOD** -Because this alternative is already operating currently. No significant challenges are expected. -The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to decrease significantly in the PSCT with the increase in the anticipated capping remedies for impacted soil areas and ponds. -Would need a 6-acre or 11-acre evaporation pond depending on the extent of capping in soil FS Area alternatives (e.g. Area 2 cap extent varies with alternatives) and other groundwater extraction alternatives. More capping area would allow discharge of a majority of the site stormwater off-site under the General NPDES permit.	**MODERATE** Capital: $1,771,000 Annual Cost: $1,834,800 Present Worth = $23,833,000 (3%, 30-yr) Present Worth = $16,551,000 (7%, 30-yr) Present Worth = $34,039,000 (3%, 100-yr) Present Worth = $18,134,000 (7%, 100-yr)	**LOW TO MODERATE** -Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -PSCT and Gallery Well extraction -GWTS treatment for PSCT groundwater. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS. -Emissions during transport and off-site disposal of Gallery Well liquids.

TABLE 11-6A
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 NORTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
3	**Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Monitoring (12 New LHSU Wells) + Treat and Discharge PSCT Groundwater to On-site Evaporation Pond + ICs + Monitoring**	**YES** -This alternative would be protective of human health and environment. -This remedy continues the existing remedial features and will contain the source indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. - ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North. There are no chemical-specific groundwater ARARs for this area because this would be within the TI waiver zone. -Will be in compliance with action-specific ARARs relating to water treatment and vapor control from NAPL storage tanks. -Will be in compliance with ARARs relating to protecting sensitive ecological species from high TDS water in the evaporation pond. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** -Would address the RAOs of containing or controlling on-site sources. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -NAPL and aqueous liquids under the P/S Landfill will be slowly removed with decreasing flow rates over the long term (up to 50 years) as the P/S Landfill is dewatered. -LNAPL is already effectively contained within the existing site containment features -LHSU plume is not migrating but new LHSU monitoring wells will serve as sentry wells -Would address the RAO of containing VOC and inorganics sources with the existing remedial features and anticipated capping for BTA, CDA and PCB Landfill s as part of the soil remedy. -COC mass reduction by extraction is modest though natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -Aquifer restoration would still take hundreds of years. Rationale for technical impracticability of remediating Area 5 North groundwater to applicable standards is presented in Appendix A. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**POOR TO MODERATE** -More contaminant mass removed with this alternative than Alt 2, but only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with PSCT and Gallery well extraction. About 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year that decreases with time as the P/S Landfill is dewatered. And about 1.9 million gallons of PSCT groundwater treated per year. -COC mass reduction by extraction is modest compared to the total contaminant mass at the site. -Natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**MODERATE TO GOOD** -Some concerns with vertical well installation in the P/S Landfill. No significant challenges with NAPL-only extraction operations. -No significant risk to human health (on-site workers or community) or environment during GWTS operation as this operation has been conducted routinely as part of normal operations.	**MODERATE TO GOOD** -Rated somewhat lower than Alt 2 because of the challenges with vertical well installation in the P/S Landfill and liquids extraction and disposal. -The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to decrease significantly in the PSCT with the increase in the anticipated capping remedies for impacted soil areas and ponds. -Would need a 6-acre or 11-acre evaporation pond depending on the extent of capping in soil FS Area alternatives (e.g. Area 2 cap extent varies with alternatives) and other groundwater extraction alternatives. -More capping area would allow discharge of a majority of the site stormwater off-site under the General NPDES permit.	**MODERATE TO HIGH** Capital: $6,068,000 Annual Cost: $2,128,400 Present Worth = $31,445,000 (3%, 30-yr) Present Worth = $22,402,000 (7%, 30-yr) Present Worth = $43,294,000 (3%, 100-yr) Present Worth = $24,240,000 (7%, 100-yr)	**MODERATE** -Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -PSCT and Gallery Well extraction -GWTS treatment of PSCT groundwater. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS. -The addition of NAPL-only extraction would result in relatively small increase in energy use and GHG emissions due to periodic operation and low energy footprint of skimmer pumps. -Emissions during transport and off-site disposal of Gallery Well liquids.

TABLE 11-6A
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 NORTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
4	**Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Monitoring (12 New LHSU Wells) + Treat and Discharge PSCT Groundwater Off-site (No Evaporation Pond) + ICs + Monitoring**	**YES** -This alternative would be protective of human health and environment. -This remedy continues the existing remedial features and will contain the source indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. - ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North, There are no chemical-specific groundwater ARARs for this area because this would be within the TI waiver zone. -Will face some challenges with compliance with action-specific ARARs relating to meeting site-specific NPDES discharge limits for inorganics including TDS and metals. -Will be in compliance with other action-specific ARARs relating to VOCs in water treatment and vapor control from NAPL storage tanks. -Will be in compliance with ARARs relating to protecting sensitive ecological species from high TDS water in the evaporation pond. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** -Same as Alt 3, but GWTS for PSCT groundwater includes inorganics treatment for off-site discharge so no on-site evaporation pond would be required. This improves effectiveness without the ecological protection concerns with evaporation ponds. However, constructing a 6-acre pond in other alternatives as a series of smaller evaporation ponds can ameliorate these concerns. -Would address the RAOs of containing or controlling on-site sources. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -NAPL and aqueous liquids under the P/S Landfill will be slowly removed with decreasing flow rates over the long term (up to 50 years) as the P/S Landfill is dewatered. -LNAPL is already effectively contained within the existing site containment features -LHSU plume is not migrating but new LHSU monitoring wells will serve as sentry wells -Would address the RAO of containing VOC and inorganics sources with the existing remedial features and anticipated capping for BTA, CDA and PCB Landfill s as part of the soil remedy. -COC mass reduction by extraction is modest though natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -Aquifer restoration would still take hundreds of years. Rationale for technical impracticability of remediating Area 5 North groundwater to applicable standards is presented in Appendix A. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**POOR TO MODERATE** -Same as Alt 3, but only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with PSCT and Gallery well extraction. About 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year and about 1.9 million gallons of PSCT groundwater treated per year. -COC mass reduction by extraction is modest compared to the total contaminant mass at the site. -Natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**MODERATE** -Rated lower than Alt 3, due to concerns with risk of failure of complex inorganics treatment process and potential release of groundwater with high inorganics to Casmalia Creek or may need an on-site pond as a contingency measure. -Same concerns with vertical NAPL-only well installation in the P/S Landfill as in Alt 3. No significant challenges with NAPL-only extraction operations. -No significant risk to human health (on-site workers or community) or environment during GWTS operation as this operation has been conducted routinely as part of normal operations.	**MODERATE** -Rated somewhat lower than Alt 3 because of the challenges with operation of the complex inorganics treatment system. -Administrative implementability challenges with obtaining a site-specific NPDES permit that would require a Basin Plan exception -The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to decrease significantly in the PSCT with the increase in the anticipated capping remedies for impacted soil areas and ponds. -Would need a 6-acre or 11-acre evaporation pond depending on the extent of capping in soil FS Area alternatives (e.g. Area 2 cap extent varies with alternatives) and other groundwater extraction alternatives. More capping area would allow discharge of a majority of the site stormwater off-site under the General NPDES permit.	**HIGH** Capital: $9,348,000 Annual Cost: $3,118,000 Present Worth = $53,750,000 (3%, 30-yr) Present Worth = $37,191,000 (7%, 30-yr) Present Worth = $77,898,000 (3%, 100-yr) Present Worth = $40,935,000 (7%, 100-yr)	**MODERATE TO HIGH** -Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -Same as Alt 3 but includes utilities for inorganics treatment in the GWTS and the emissions from transportation and disposal of waste brine. -GWTS treatment for organics and inorganics in PSCT groundwater. -PSCT and Gallery Well extraction -Consumption of materials such as LPGAC and VPGAC associated with the GWTS and RO membranes. -The addition of NAPL-only extraction would result in relatively small increase in energy use and GHG emissions due to periodic operation and low energy footprint of skimmer pumps. -Emissions during transport and off-site disposal of Gallery Well liquids.

TABLE 11-6A
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 NORTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
5	**Extraction (PSCT, Gallery Well) + Extraction (Aggressive, 16 Large Diameter NAPL wells) + Extraction (NAPL-only in CDA, 4 existing wells) + Monitoring (12 new LHSU Wells) + Treat and Discharge to On-site Evaporation Pond + ICs + Monitoring**	**YES** -This alternative would be protective of human health and environment. -This remedy continues the existing remedial features and will contain the source indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. - ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North, There are no chemical-specific groundwater ARARs for this area because this would be within the TI waiver zone. -Will face challenges in compliance with action-specific ARARs relating to vapor treatment to meet SBAPCD requirements. Will be in compliance with other issues such water treatment requirements and vapor control from NAPL storage tanks. -Will face challenges in compliance with ARARs relating to protecting sensitive ecological species from high TDS water especially with the larger evaporation ponds 11 acres or larger. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** - Would recover more contaminant mass with this more aggressive extraction than Alt 3, but COC mass reduction would still be very small compared to total mass of contaminants in groundwater. Hence it is rated the same as Alt 3. -Would address the RAOs of containing or controlling on-site sources. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -NAPL and aqueous liquids under the P/S Landfill will be extracted with flow rates decreasing over a period of 10 to 20 years as the P/S Landfill is dewatered. -LNAPL is already effectively contained within the existing site containment features but limited extraction is proposed from 4 existing wells to ensure no migration. -LHSU plume is not migrating but new LHSU monitoring wells will serve as sentry wells -Would address the RAO of containing VOC and inorganics sources with the existing remedial features and anticipated capping for BTA, CDA and PCB Landfill s as part of the soil remedy. -COC mass reduction by extraction is modest though natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -Aquifer restoration would still take hundreds of years. Rationale for technical impracticability of remediating Area 5 North groundwater to applicable standards is presented in Appendix A. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**MODERATE** -Would recover more contaminant mass compared to Alt 3 so is rated higher. Only modest reduction in toxicity, mobility and volume is expected compared to the total contaminant mass at the site. -Aggressive extraction will dewater the P/S LF by initially removing 10 gpm (5.2 million gallons) the first year and then decreasing every year over a 20-year period. -This alternative includes source control with PSCT and Gallery well extraction with about 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year and about 1.9 million gallons of PSCT groundwater treated per year. -Natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**POOR TO MODERATE** -Rated lower than Alt 3, due to risks associated with installation of large diameter vertical NAPL extraction wells inside the P/S landfill that would involve drilling through waste. -Potential impacts to ecological species due to the difficulty with providing protection with larger evaporation ponds as required with this alternative -Potential for exposures to VOCs and other subsurface contaminants for construction workers. -Moderate risk to human health (on-site workers or community) and environment (potential leaks) during operation of this pump and treat system as this would involve treating highly concentrated leachate on-site.	**POOR TO MODERATE** -Rated somewhat lower than Alt 3 because of challenges expected with large diameter well installation down to 80 feet bgs inside the P/S Landfill. -Challenges anticipated with LTP treatment technology (Air stripping, LPGAC or BioPACT and LPGAC) and equipment air emissions control and reliability of contaminant removal efficiency. -Uncertainties with the performance of the on-site leachate treatment plant to adequately treat extremely high contaminant levels. Uncertainties with extraction rates and amounts of NAPL recoverable. -Would need a larger evaporation pond (~20 acres) than previous alternatives for the treated leachate from the LTP estimated at an additional 5.2 million gallons per year. Additional capacity may be need depending on the extent of capping in soil FS Area alternatives (e.g. Area 2 cap extent varies with alternatives) and other groundwater extraction alternatives.	**HIGH** Capital: $17,576,000 Annual Cost: $3,021,000 Present Worth = $44,037,000 (3%, 30-yr) Present Worth = $33,926,000 (7%, 30-yr) Present Worth = $57,316,000 (3%, 100-yr) Present Worth = $35,985,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: - PSCT and Gallery Well extraction -16 NAPL well extraction - GWTS treatment of PSCT groundwater and consumption of materials such as LPGAC and VPGAC -Leachate treatment of 5.2 million gallons per year using air stripping+ LPGAC or Bio-PACT technology including electricity for transfer pumps, aeration blowers and LPGAC for polishing and VPGAC for vapor treatment. -Emissions during transport and off-site disposal of Gallery Well and NAPL-only liquids. -The addition of aggressive NAPL extraction would result in significant increase in energy use/GHG emissions due to continuous operation of extraction pumps and the leachate treatment plant.

TABLE 11-6A
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 NORTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
6	**Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells)/ Dispose Off-site + Extraction (NAPL-only in CDA, 4 existing wells) + Monitoring (12 new LHSU Wells) + Treat and Discharge to On-site Evaporation Pond + ICs + Monitoring**	**YES** -This alternative would be protective of human health and environment. -This remedy continues the existing remedial features and will contain the source indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. - ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North, There are no chemical-specific groundwater ARARs for this area because this would be within the TI waiver zone. -Will face challenges in compliance with action-specific ARARs relating to vapor treatment to meet SBAPCD requirements. Will be in compliance with other issues such water treatment requirements and vapor control from NAPL storage tanks. -Will face challenges in compliance with ARARs relating to protecting sensitive ecological species from high TDS water especially with the larger evaporation ponds 11 acres or larger. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** - Would recover more contaminant mass with this more aggressive extraction than Alt 3, but COC mass reduction would still be very small compared to total mass of contaminants in groundwater. Also, the extracted liquids are sent off-site for disposal which transfers the risk to other off-site locations and presents an additional long term risk and liability. Hence this alternative is rated the same as Alt 3. -Would address the RAOs of containing or controlling on-site sources. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -NAPL and aqueous liquids under the P/S Landfill will be dewatered with flow rates decreasing over a period of 10 to 20 years. -LNAPL is already effectively contained within the existing site containment features but limited extraction is proposed from 4 existing wells to ensure no migration. -LHSU plume is not migrating but new LHSU monitoring wells will serve as sentry wells and can be converted to extraction wells if needed. -Would address the RAO of containing VOC and inorganics sources with the existing remedial features and anticipated capping for BTA, CDA and PCB Landfill s as part of the soil remedy. -COC mass reduction by extraction is modest though natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -Aquifer restoration would still take hundreds of years. Rationale for technical impracticability of remediating Area 5 North groundwater to applicable standards is presented in Appendix A. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**MODERATE** -Would recover more contaminant mass compared to Alt 3 and hence is rated higher. But only modest reduction in toxicity, mobility and volume is expected compared to the total contaminant mass at the site. -Dewatering P/S LF is assumed to remove 5.2 million gallons the first year and then decreasing every year and recover on average 200,000 gallons per year after the sixth year. -This alternative includes source control with PSCT and Gallery well extraction with about 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year and about 1.9 million gallons of PSCT groundwater treated per year. -Natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**POOR TO MODERATE** -Rated lower than Alt 3, due to risks associated with installation of horizontal wells under the clay barrier and tracking the bottom of the P/S Landfill. -Significant concerns with potential release of liquids or drilling muds and avoidance of drilling through waste drums. -Potential for exposures to VOCs and other subsurface contaminants for drillers and on-site workers. -Moderate risk to human health (on-site workers or community) and environment (potential leaks) during operation of this pump and treat system as this would involve treating highly concentrated leachate on-site. -Long term liability concerns with transportation and disposal of P/S LF liquids at off-site TSDFs.	**POOR TO MODERATE** -Rated lower than Alt 3 because of significant challenges expected with installation of horizontal wells under the clay barrier and the P/S Landfill. See horizontal well risk analysis in Table 10-6A-1. -Significant challenges with tracking the bottom of the landfill without drilling into the waste/drums -Likelihood of borehole failure with blind drilling and potential for casing breakage while pushing casing into borehole. -Uncertainties with extraction rates and amounts of NAPL recoverable. -Would need a 6-acre or 11-acre evaporation pond depending on the extent of capping in soil FS Area alternatives (e.g. Area 2 cap extent varies with alternatives) and other groundwater extraction alternatives.	**HIGH** Capital: $13,824,000 Annual Cost: $6,527,000 Present Worth = $56,755,000 (3%, 30-yr) Present Worth = $45,424,000 (7%, 30-yr) Present Worth = $69,821,000 (3%, 100-yr) Present Worth = $47,450,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -Five 600-ft long horizontal wells installation -Dewater liquids pumping and separation system -Emissions during transport and off-site disposal of the P/S Landfill liquids assumed to be 5.2 million gallons initially decreasing to a steady state of 200,000 gallons per year and Gallery Well liquids at 450,000 gallons per year. -PSCT and Gallery Well extraction -GWTS treatment of PSCT groundwater for organics for on-site discharge to evaporation pond. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS.

TABLE 11-6A
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 NORTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
7	**Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells)/Dispose Off-site + Extraction (NAPL-only in CDA, 12 new wells) + Extraction (4 new LHSU wells) + Monitoring (8 new LHSU wells) + Treat PSCT GW and Discharge Off-site + ICs + Monitoring**	**YES** -This alternative would be protective of human health and environment. -This remedy continues the existing remedial features and will contain the source indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. - ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North, There are no chemical-specific groundwater ARARs for this area because this would be within the TI waiver zone. -Will face challenges in compliance with action-specific ARARs relating to vapor treatment to meet SBAPCD requirements. Will be in compliance with other issues such water treatment requirements and vapor control from NAPL storage tanks. -Will face challenges in compliance with ARARs relating to protecting sensitive ecological species from high TDS water especially with the larger evaporation ponds 11 acres or larger. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** - Would recover more contaminant mass with this more aggressive extraction than Alt 3, but COC mass reduction would still be very small compared to total mass of contaminants in groundwater. Also, the extracted liquids are sent off-site for disposal which transfers the risk to other off-site locations and presents an additional long term risk and liability. Hence this alternative is rated the same as Alt 3. -Would address the RAOs of containing or controlling on-site sources. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -LNAPL is already effectively contained within the existing site containment features but active NAPL skimming is proposed from 12 new wells to enhance NAPL removal. -LHSU plume is not migrating but 4 new LHSU extraction wells will provide limited extraction to enhance containment -Would address the RAO of containing VOC and inorganics sources with the existing remedial features and anticipated capping for BTA, CDA and PCB Landfill s as part of the soil remedy. -COC mass reduction by extraction is modest though natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -Aquifer restoration would still take hundreds of years. Rationale for technical impracticability of remediating Area 5 North groundwater to applicable standards is presented in Appendix A. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**MODERATE** -Would recover more contaminant mass compared to Alt 3 and hence is rated higher. But only modest reduction in toxicity, mobility and volume is expected compared to the total contaminant mass at the site. -This alternative includes source control with PSCT and Gallery well extraction with about 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year and about 1.9 million gallons of PSCT groundwater treated per year. -Natural attenuation especially of the VOCs in Area 5 North is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**POOR TO MODERATE** -Rated lower than Alt 3, due to risks associated with installation of horizontal wells under the clay barrier and tracking the bottom of the P/S landfill. -Significant concerns with potential release of liquids or drilling muds and avoidance of drilling through waste drums. -Potential for exposures to VOCs and other subsurface contaminants for drillers and on-site workers. -Moderate risk to human health (on-site workers or community) and environment (potential leaks) during operation of this pump and treat system as this would involve treating highly concentrated leachate on-site. -Long term liability concerns with transportation and disposal of P/S LF liquids at off-site TSDFs.	**POOR TO MODERATE** -Rated lower than Alt 3 because of significant challenges expected with installation of horizontal wells under the clay barrier and the P/S landfill. -Significant challenges with tracking the bottom of the landfill without drilling into the waste/drums -Likelihood of borehole failure with blind drilling and potential for casing breakage while pushing casing into borehole. -Uncertainties with extraction rates and amounts of NAPL recoverable. -Administrative implementability challenges with obtaining a site-specific NPDES permit that would require a Basin Plan exception -Would need a 6-acre or 11-acre evaporation pond depending on the extent of capping in soil FS Area alternatives (e.g. Area 2 cap extent varies with alternatives) and other groundwater extraction alternatives.	**HIGH** Capital: $17,558,000 Annual Cost: $7,536,000 Present Worth = $79,820,000 (3%, 30-yr) Present Worth = $60,789,000 (7%, 30-yr) Present Worth = $105,225,000 (3%, 100-yr) Present Worth = $64,727,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -Five 600-ft long horizontal wells installation -Dewater liquids pumping and separation system -Emissions during transport and off-site disposal of the P/S Landfill liquids assumed to be 5.2 million gallons initially decreasing to a steady state of 200,000 gallons per year and Gallery Well liquids at 450,000 gallons per year. -PSCT and Gallery Well extraction -GWTS treatment of PSCT groundwater for inorganics and organics to discharge and includes energy-intensive reverse osmosis process. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS and RO membranes.

NOTES

1. A TI (Technical Impracticability) waiver of chemical-specific groundwater ARARs for Area 5 North as presented in the TI evaluation (Appendix A) is assumed to be granted by the USEPA.
2. Cost estimates are provided in Appendix E. The cost estimates are approximate (+50%/-30%) and include a contingency of 35 to 50%.
3. Monitoring refers to periodic groundwater monitoring of wells sitewide to monitor performance of the remedial components of the alternatives.
4. Anticipated capping remedies for the site are expected to significantly reduce surface water infiltration and potential for contaminant migration. Also, groundwater extraction flow rates are expected to decrease based on groundwater flow modeling.
5. Green impacts assessment is a qualitative rating (low, medium, high) of environmental impacts (footprint) based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative. The higher the rating, the greater the impacts and hence, the less green the alternative.

TABLE 11-6B
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 SOUTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
1	**No Action**	**NO** -Would not be protective because it does not include any remediation or long term controls and future owners or construction workers could encounter contamination.	**NO** -This alternative would not meet the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NONE**	**NONE**
2	**Extraction (PCT-A, PCT-B) + Treat and Discharge to On-site Evaporation Pond + MNA + ICs + Monitoring**	**YES** -This remedy continues the existing extraction at PCT-A and PCT-B and will contain the source with excavation or capping of impacted soils and prevent off-site migration indefinitely into the future. -The timeframe for aquifer restoration was estimated to be 260 years for arsenic [6] that is not significantly greater than the aggressive restoration alternative (Alternative 5). -ICs would control potential exposures to groundwater contamination. Also, it should be noted that the low level inorganic and organic contaminants in groundwater do not pose any present risk to humans or ecological species as there is no pathway for exposure.	**YES** -Will be in compliance with action-specific ARARs relating to extraction and evaporation in the proposed evaporation pond. -Will be in compliance with requirements to protect sensitive species from high TDS water in the evaporation pond. -Chemical-specific ARARs for groundwater will not be met for inorganics for a long time because of the timeframe to reach MCL levels with any of these alternatives. -This alternative would be in compliance with groundwater ARARs at off-site locations. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** -Would address the RAOs of containing or controlling on-siteon-site sources and mitigating potential off-site migration by capping or excavation of Ponds A/B, the MSA and the Hotspot Location 4 near PSCT-1 as part of the soil remedial alternatives. -Would address the off-site migration RAO by continuing operation of the PCT-A and PCT-B extraction wells. - COC mass reduction by extraction is modest though natural attenuation especially of the VOCs in Area 5 South is documented and will contribute to mass reduction over the long term. For inorganics (specifically arsenic), aquifer restoration estimated to be 260 years assuming capping cuts off the source to groundwater [6]. - With ICs and monitoring included there is no potential for exposure to groundwater contaminants. Also, it should be noted that the low levels of organics and inorganics in groundwater does not pose any present risk to humans or ecological species as there is no pathway for exposure.	**POOR TO MODERATE** -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with excavation or capping of the source areas in FS Area 3 and closure of ponds (RCF Pond) that would prevent or reduce infiltration through contaminated soil and minimize leaching to groundwater. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. Contaminants would be flushed in over a long period of time to be captured by the extraction at the perimeter. -Natural attenuation especially of the VOCs in Area 5 South is documented and will contribute to mass reduction (Appendix G). -This alternative with perimeter extraction and natural attenuation will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**GOOD** – No significant risk to human health (on-site workers or community) or environment during operation as this operation has been conducted routinely as part of normal operations. This remedial component is already operating at the site.	**GOOD** - Because this alternative is already operating currently. No significant challenges are expected. - The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to decrease significantly in the PCT-A with the increase in the anticipated capping remedies for impacted soil areas and ponds. - A 6-acre evaporation pond would be adequate assuming capping of soil areas will allow discharge of a majority of the site stormwater off-site under the General NPDES permit.	**LOW TO MODERATE** Capital: $1,781,000 Annual Cost: $305,000 Present Worth = $7,667,000 (3%, 30-yr) Present Worth = $5,216,000 (7%, 30-yr) Present Worth = $11,863,000 (3%, 100-yr) Present Worth = $5,867,000 (7%, 100-yr)	**MODERATE** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -PCT-A, PCT-B extraction -GWTS treatment of PCT groundwater if needed. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS (if used).

TABLE 11-6B
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 SOUTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
3	**Extraction (PCT-A, PCT-B) + Treat and Discharge Off-site + MNA + ICs + Monitoring** - 10 gpm system	**YES** -This remedy continues the existing extraction at PCT-A and PCT-B and will contain the source with capping or excavation of impacted soils and prevent off-site migration indefinitely into the future. -The timeframe for aquifer restoration was estimated to be 260 years for arsenic [6] that is not significantly greater than the aggressive restoration alternative (Alternative 5). -ICs would control potential exposures to groundwater contamination. Also, it should be noted that this impacted groundwater with inorganics does not pose any present risk to humans or ecological species as there is no pathway for exposure.	**YES** -Will be in compliance with action-specific ARARs relating to extraction and evaporation in the proposed evaporation pond. However, challenges can be expected in reliably meeting inorganics (TDS, metals, etc.) limits in NPDES permit. -Will be in compliance with requirements to protect sensitive species from high TDS water in the evaporation pond. -Chemical-specific ARARs for groundwater will not be met for inorganics for a long time because of the timeframe to reach MCL levels with any of these alternatives. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** -Would address the RAO of containing sources with the capping or excavation of impacted soil source areas in FS Area 3 and the closure of the ponds (RCF Pond) as part of the soil remedy. -Would address the off-site migration RAO by continuing operation of the PCT-A and PCT-B extraction wells. -Some COC natural attenuation would occur slowly through dissolution and dispersion and aquifer restoration for inorganics (arsenic) was estimated to be 260 years assuming capping cuts off the source to groundwater [6]. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants. Also, it should be noted that this impacted groundwater with inorganics does not pose any present risk to humans or ecological species as there is no pathway for exposure.	**POOR TO MODERATE** -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with excavation or capping of the source areas in FS Area 3 and closure of ponds (RCF Pond) that would prevent or reduce infiltration through contaminated soil and minimize leaching to groundwater. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. Contaminants would be flushed in over a long period of time to be captured by the extraction at the perimeter. -This alternative will continue to remove inorganic contaminants in groundwater at a slow rate by dilution and dispersion that are expected to remain in groundwater for decades.	**MODERATE** -No significant risk to human health (on-site workers or community) or environment during operation. However, there is some concern with reliability of treatment of very high inorganics in groundwater attempting to reach stringent NPDES limits. There is potential for system failures that result in discharge of treated groundwater with high inorganics levels into Casmalia Creek.	**MODERATE** -Because this alternative includes treatment of inorganics in groundwater for discharge off-site in accordance with stringent NPDES limits. -The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to decrease in the PCT-A and PCT-B with the increase in the anticipated capping remedies for impacted soil areas and ponds. -An evaporation pond would not be required since this groundwater is treated for inorganics and discharged off-site.	**MODERATE TO HIGH** Capital: $4,440,000 Annual Cost: $1,693,000 Present Worth = $37,233,000 (3%, 30-yr) Present Worth = $24,475,000 (7%, 30-yr) Present Worth = $58,575,000 (3%, 100-yr) Present Worth = $27,784,000 (7%, 100-yr)	**MODERATE TO HIGH** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -PCT-A, PCT-B extraction -GWTS treatment of PSCT groundwater for inorganics and if needed in future for organics. Treatment technology including reverse osmosis, VSEP and LPGAC including electricity for transfer pumps, aeration blowers and LPGAC for polishing -Consumption of materials such as LPGAC and VPGAC associated with the GWTS. -Emissions during transport and off-site disposal of brine, carbon, filter and other wastes.
4	**Extraction (PCT-A) + In-Situ Reactive Wall (PCT-B) + MNA + ICs + Monitoring**	**YES** -This alternative continues the existing extraction at PCT-A and an in-situ reactive wall for PCT-B. It will contain the source with capping or excavation of impacted soils and prevent off-site migration by perimeter control indefinitely into the future. -The timeframe for aquifer restoration was estimated to be 260 years for arsenic [6] that is not significantly greater than the aggressive restoration alternative (Alternative 5). -ICs would control potential exposures to groundwater contamination. Also, it should be noted that this impacted groundwater with inorganics does not pose any present risk to humans or ecological species as there is no pathway for exposure.	**YES** -Will be in compliance with action-specific ARARs relating to extraction and evaporation in the proposed evaporation pond. -Will be in compliance with requirements to protect sensitive species from high TDS water in the evaporation pond. -Chemical-specific ARARs for groundwater will not be met for inorganics for a long time because of the timeframe to reach MCL levels with any of these alternatives. -This alternative would be in compliance with groundwater ARARs at off-site locations. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**POOR TO MODERATE** -Would address the off-site migration RAO by converting the PCT-B clay barrier to an in-situ reactive wall that treats inorganic contaminants and continues extraction for PCT-A. But the reactive wall has effectiveness limitations because of the complexity associated with remediating multiple metals with different redox chemistries and the very high TDS which can significantly reduce the lifetime of the reactive wall. -Would address the RAO of containing sources with the capping or excavation of impacted soil source areas in FS Area 3 and the closure of the ponds (RCF Pond) as part of the soil remedy. -Some COC natural attenuation would occur slowly through dissolution and dispersion and aquifer restoration for inorganics (arsenic) was estimated to be 260 years assuming capping cuts off the source to groundwater [6]. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**POOR TO MODERATE** -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with excavation or capping of the source areas in FS Area 3 and closure of ponds (RCF Pond) that would prevent or reduce infiltration through contaminated soil and minimize leaching to groundwater. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. Contaminants would be flushed in over a long period of time to be captured by the extraction at the perimeter. -This alternative will continue to remove inorganic contaminants in groundwater at a slow rate by dilution and dispersion that are expected to remain in groundwater for decades.	**MODERATE TO GOOD** -No significant risk to human health (on-site workers or community) or environment. -Some on-site worker risks associated with construction of ZVI reactive barriers (gates) at PCT-B. Potential for exposures to VOCs and other subsurface contaminants for construction workers.	**MODERATE** -Minor technical challenges also can be expected with installation of the ZVI gates by cutting slots in the clay barrier. -The extraction component of the alternative is already implemented. -There are reliability concerns with the ZVI reactive walls in addressing a mix of multiple metals with different redox chemistries. -A smaller 6-acre evaporation pond would be adequate assuming capping of soil areas that allow discharge of a majority of the site stormwater off-site under the General NPDES permit.	**MODERATE** Capital: $2,456,000 Annual Cost: $220,000 Present Worth = $7,407,000 (3%, 30-yr) Present Worth = $5,124,000 (7%, 30-yr) Present Worth = $10,863,000 (3%, 100-yr) Present Worth = $5,660,000 (7%, 100-yr)	**LOW TO MODERATE** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -PCT-B reactive wall construction and periodic ZVI replacement -PCT-A extraction -GWTS treatment of PCT groundwater (if needed). -Consumption of materials such as LPGAC associated with the GWTS. Impacts are rated lower than Alts 2, 3 because of lower groundwater extraction rates from the PCTs and the reactive wall is a passive technology that does not consume fuel or electricity.

TABLE 11-6B
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 SOUTH - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
5	**Aggressive Extraction (40 New Large Diameter Extraction Wells) + Extraction (PCT-A, PCT-B) + Treat and Discharge Off-site + MNA + ICs + Monitoring** - 20 gpm (0.5 gpm/well) - PCT-A, B flows - Use 30 gpm system	**YES** -This alternative includes aggressive extraction as a restoration alternative to achieve MCLs for inorganics in groundwater. -This alternative continues the existing extraction at PCT-A and PCT-B and will contain the source with capping impacted soils and prevent off-site migration indefinitely into the future. -The timeframe for aquifer restoration would be several decades ant not significantly less than the previous alternatives. -ICs would control potential exposures to groundwater contamination.	**YES** -This alternative is included as a restoration alternative to reach MCLs. -Chemical-specific ARARs for groundwater will not be met for inorganics for a long time because of the timeframe to reach MCL levels with this aggressive restoration alternative. -This alternative would be in compliance with groundwater ARARs at off-site locations. -Some challenges in meeting action-specific groundwater treatment ARARs and RWQCB and SBCAPCD requirements with this complex groundwater treatment system can be anticipated. This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** -Aggressive extraction at 30 gpm across Area 5 South would reduce organic and inorganic contaminant concentrations at a slightly faster rate. However, the rate of contaminant removal will be very slow because the average concentrations of organics and inorganics in 30 gpm extracted stream will be very low (a few 10s of μg/l). -As discussed in the TIE, once the VOCs have incorporated into the clay matrix, even with use of aggressive technologies it could take hundreds of years to restore the aquifer because the reverse diffusion out of matrix can take hundreds of years. Rationale for technical impracticability of remediating sitewide groundwater to applicable standards is presented in Appendix A. With ICs and monitoring included there is no potential for exposure to groundwater contaminants. -Would address the RAO of containing sources with the capping of the metals-impacted soil source areas in the FS Area 3 and the closure of the ponds (RCF Pond) as part of the soil remedy. -Would address the off-site migration RAO by continuing operation of the PCT-A and PCT-B extraction feature at the perimeter. -Some COC natural attenuation would occur slowly through dissolution and dispersion and aquifer restoration would still take decades not significantly different from previous alternatives.	**MODERATE** -This more aggressive technology would remove contaminant mass at a very low rate (likely < 10 lbs/year for each metal) due to the low extracted groundwater concentrations anticipated in the low 10s of μg/l. -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping of the soil source areas in FS Area 3 and RCF Pond that would prevent infiltration and minimize leaching. -COC mass reduction by extraction is still small compared to the total contaminant mass at the site. -Even with this alternative, aquifer restoration could take hundreds of years.	**MODERATE** -Concerns with potential release of high TDS water to Casmalia Creek due to treatment system failure and resulting non-compliance with NPDES permit limits. This could lead to potential concerns with exposure to ecological species. -Potential for exposures to subsurface contaminants for construction workers/drillers. -Minor risk to human health (on-site workers or community) and environment (potential leaks) during operation of this complex groundwater treatment system.	**POOR TO MODERATE** -Challenges anticipated with complex reverse osmosis and VSEP treatment system and installation of a large number of extraction wells and piping. -Would need to dispose 2.4 million gallons of brine a year. We have assumed off-site disposal by truck. If handled on-site, a larger evaporation pond would be needed to handle the reject RO stream. -Challenges with equipment reliability of contaminant removal efficiency. -Large quantities of waste inorganic solids generated in removing high TDS levels estimated at more than 100,000 lbs per year prior to NPDES compliant discharge.	**HIGH** Capital: $14,211,000 Annual Cost: $4,030,000 Present Worth = $91,720,000 (3%, 30-yr) Present Worth = $60,958,000 (7%, 30-yr) Present Worth = $141,787,000 (3%, 100-yr) Present Worth = $68,720,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: -PCT-A, PCT-B -30 gpm extraction and groundwater treatment system -Large volume of brine for off-site trucking and disposal -Treatment technology including reverse osmosis, VSEP including electricity for transfer pumps, aeration blowers and LPGAC for polishing. -Emissions during transport and off-site disposal/ regeneration of carbon and filter wastes.

NOTES

1. A TI (Technical Impracticability) waiver of chemical-specific groundwater ARARs for Area 5 North as presented in the TI evaluation (Appendix A) is assumed to be granted by the USEPA.
2. Cost estimates are provided in Appendix E. The cost estimates are approximate (+50%/-30%) and include a contingency of 35 to 50%.
3. Monitoring refers to periodic groundwater monitoring of wells sitewide to monitor performance of the remedial components of the alternatives.
4. Anticipated capping remedies for the site are expected to significantly reduce surface water infiltration and potential for contaminant migration. Also, groundwater extraction flow rates are expected to decrease based on groundwater flow modeling.
5. Green impacts assessment is a qualitative rating of environmental impacts (footprint) based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative. The higher the rating, the greater the impacts and hence, the less green the alternative.
6. Appendix A presents a time frame for aquifer restoration for Area 5 South to be in the range of 80 years for nickel to 260 years for arsenic assuming source removal. Aquifer restoration time frames with capping of sources and pond closure remedies are expected to be similar to that for source removal. Typically arsenic is present at higher concentrations in groundwater than other metals. Modeling details are presented in Appendix D.

TABLE 11-6C
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 WEST - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
1	**No Action** - Assumes no extraction at the PCT-C, no soil capping remedies for upgradient source areas and no groundwater monitoring is conducted.	**NO** **–** This alternative would not be protective of human health and the environment because it does not control or reduce potential future exposure to contamination.	**NO** **–** This alternative does not meet the state ARAR requiring a restrictive covenant when waste is left in place beyond a level of unrestricted used levels.	**NOT APPLICABLE** **-**This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** **-**This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** **-**This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** **-**This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NONE**	**NONE**
2	**Extraction (PCT-C) + Treat and Discharge to On-siteOn-site Evaporation Pond + MNA + ICs + Monitoring**	**YES** **-**This remedy continues the existing extraction at PCT-C and will contain the source with capping impacted soils and prevent off-site migration indefinitely into the future. -The timeframe for aquifer restoration was estimated to be 220 years for arsenic [6] that is not significantly greater than the aggressive restoration alternative (Alternative 5). -ICs would control potential exposures to groundwater contamination. Also, it should be noted that this impacted groundwater with inorganics does not pose any present risk to humans or ecological species as there is no pathway for exposure.	**YES** **-**This alternative would be in compliance with groundwater ARARs at off-site locations. -Will be in compliance with action-specific ARARs relating to extraction and evaporation in the proposed evaporation pond. -Will be in compliance with requirements to protect sensitive species from high TDS water in the evaporation pond. -Chemical-specific ARARs for groundwater will not be met for inorganics for a long time because of the timeframe to reach MCL levels with any of these alternatives. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** **-**Would address the RAO of containing sources with the capping of the metals-impacted soil source areas in the RCRA Canyon/WCSA and the closure of the ponds (A-5 and A-Series) as part of the soil remedy. -Would address the off-site migration RAO by continuing operation of the PCT-C extraction wells. -Some COC natural attenuation would occur slowly through dissolution and dispersion and aquifer restoration for arsenic was estimated to be 220 years assuming capping cuts off the source to groundwater [6]. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants. Also, it should be noted that this impacted groundwater with inorganics does not pose any present risk to humans or ecological species as there is no pathway for exposure.	**POOR TO MODERATE** **-**Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping of the metals source areas in the RCRA Canyon/WCSA and closure of ponds (Pond A-5 and A-Series Pond) that would prevent infiltration and minimize leaching. Clean groundwater would flush in from the north over a long period of time flush the contaminants out to be captured by the extraction at the perimeter. This alternative will continue to remove inorganic contaminants in groundwater at a slow rate by dilution and dispersion that are expected to remain in groundwater for decades.	**GOOD** **-**No significant risk to human health (on-site workers or community) or environment during operation as this operation has been conducted routinely as part of normal operations. This system is already operating at the site.	**GOOD** **-**Because this alternative is already operating currently. No significant challenges are expected. -The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to not change significantly in the PCT-C with the increase in the anticipated capping remedies for impacted soil areas and ponds. -A 6-acre evaporation pond would be adequate assuming capping of soil areas that allow discharge of a majority of the site stormwater off-site under the General NPDES permit.	**MODERATE** Capital: $2,633,000 Annual Cost: $258,000 Present Worth = $7,509,000 (3%, 30-yr) Present Worth = $5,290,000 (7%, 30-yr) Present Worth = $11,144,000 (3%, 100-yr) Present Worth = $5,853,000 (7%, 100-yr)	**LOW TO MODERATE** Green and sustainability impacts are based on electricity usage and GHG emissions for: - PCT-C extraction

TABLE 11-6C
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 WEST - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
3	**Extraction (PCT-C) + Treat and Discharge Off-site + MNA + ICs + Monitoring** - 10 gpm system	**YES** -This remedy continues the existing extraction at PCT-C and will contain the source with capping impacted soils and prevent off-site migration indefinitely into the future. -The timeframe for aquifer restoration was estimated to be 220 years for arsenic [6] that is not significantly greater than the aggressive restoration alternative (Alternative 5). -ICs would control potential exposures to groundwater contamination. Also, it should be noted that this impacted groundwater with inorganics does not pose any present risk to humans or ecological species as there is no pathway for exposure.	**YES** -Will be in compliance with action-specific ARARs relating to extraction and evaporation in the proposed evaporation pond. However, challenges can be expected in reliably meeting inorganics (TDS, metals, etc.) limits in NPDES permit. -Will be in compliance with requirements to protect sensitive species from high TDS water in the evaporation pond. -Chemical-specific ARARs for groundwater will not be met for inorganics for a long time because of the timeframe to reach MCL levels with any of these alternatives. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** -Would address the RAO of containing sources with the capping of the metals-impacted soil source areas in the RCRA Canyon/WCSA and the closure of the ponds (A-5 and A-Series) as part of the soil remedy. -Would address the off-site migration RAO by continuing operation of the PCT-C extraction wells. -Some COC natural attenuation would occur slowly through dissolution and dispersion and aquifer restoration for arsenic was estimated to be 220 years assuming capping cuts off the source to groundwater [6]. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants. Also, it should be noted that this impacted groundwater with inorganics does not pose any present risk to humans or ecological species as there is no pathway for exposure.	**POOR TO MODERATE** -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping of the metals source areas in the RCRA Canyon/WCSA and closure of ponds (Pond A-5 and A-Series Pond) that would prevent infiltration and minimize leaching. -Clean groundwater would flush in from the north over a long period of time flush the contaminants out to be captured by the extraction at the perimeter. -This alternative will continue to remove inorganic contaminants in groundwater at a slow rate by dilution and dispersion that are expected to remain in groundwater for decades.	**MODERATE** -No significant risk to human health (on-site workers or community) or environment during operation. However, there is some concern with reliability of treatment of very high inorganics in groundwater attempting to reach stringent NPDES limits. There is potential for system failures that result in discharge of treated groundwater with high inorganics levels into Casmalia Creek.	**MODERATE** -Because this alternative includes treatment of inorganics in groundwater for discharge off-site in accordance with stringent NPDES limits. -The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to not change significantly in the PCT-C with the increase in the anticipated capping remedies for impacted soil areas and ponds. -An evaporation pond would not be required since this groundwater is treated for inorganics and discharged off-site.	**MODERATE TO HIGH** Capital: $5,005,000 Annual Cost: $1,719,000 Present Worth = $38,244,000 (3%, 30-yr) Present Worth = $25,231,000 (7%, 30-yr) Present Worth = $59,843,000 (3%, 100-yr) Present Worth = $28,579,000 (7%, 100-yr)	**MODERATE TO HIGH** Green and sustainability impacts are based on electricity usage and GHG emissions for: - PCT-C extraction -Treatment technology including reverse osmosis, VSEP and LPGAC including electricity for transfer pumps, aeration blowers and LPGAC for polishing -Emissions during transport and off-site disposal/ regeneration of carbon and filter wastes.
4	**In-Situ Reactive Wall (PCT-C) + MNA + ICs + Monitoring**	**YES** - This remedy continues the existing capture at PCT-C with an in-situ reactive wall and will contain the source with capping impacted soils and prevent off-site migration indefinitely into the future. -The timeframe for aquifer restoration was estimated to be 220 years for arsenic [6] that is not significantly greater than the aggressive restoration alternative (Alternative 5). -ICs would control potential exposures to groundwater contamination.	**YES** -This alternative would be in compliance with groundwater ARARs at off-site locations. -Since this alternative is a passive in-situ reactive wall there is no extraction or treatment-related ARARs. -Chemical-specific ARARs for groundwater will not be met for inorganics for a long time because of the timeframe to reach MCL levels with any of these alternatives. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**POOR TO MODERATE** -Would address the off-site migration RAO by converting the PCT-C clay barrier to an in-situ reactive wall that treats inorganic contaminants and ensures capture. But the reactive wall has effectiveness limitations because of the complexity associated with remediating multiple metals with different redox chemistries and the very high TDS which can significantly reduce the lifetime of the reactive wall. -Would address the RAO of containing sources with the capping of the metals-impacted soil source areas in the RCRA Canyon/WCSA and the closure of the ponds (Pond A-5 and A-Series Pond) as part of the soil remedy. -Some COC natural attenuation would occur slowly through dissolution and dispersion and aquifer restoration for arsenic was estimated to be 220 years assuming capping cuts off the source to groundwater [6]. -With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**POOR TO MODERATE** -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping of the metals source areas in the RCRA Canyon/WCSA and the closure of ponds (Pond A-5 and A-Series Pond) that would prevent infiltration and minimize leaching. -Clean groundwater would flush in from the north over a long period of time flush the contaminants out to be captured by the reactive wall at the perimeter. -This alternative will continue to remove inorganic contaminants in groundwater at a slow rate by dilution and dispersion that are expected to remain in groundwater for decades.	**MODERATE TO GOOD** -No significant risk to human health (on-site workers or community) or environment during operation. -Some on-site worker risks associated with construction of ZVI reactive barriers (gates) at PCT-C and periodic replacement of ZVI. Potential for exposures to subsurface contaminants for construction workers during installation.	**MODERATE** -Minor technical challenges also can be expected with installation of the ZVI gates by cutting slots in the clay barrier. The extraction component of the alternative is already implemented. There are reliability concerns with the ZVI reactive walls in addressing a mix of multiple metals with different redox chemistries. -A smaller 6-acre evaporation pond would be adequate assuming capping of soil areas that allow discharge of a majority of the site stormwater off-site under the General NPDES permit.	**MODERATE** Capital: $4,450,000 Annual Cost: $155,000 Present Worth = $9,834,000 (3%, 30-yr) Present Worth = $6,912,000 (7%, 30-yr) Present Worth = $13,256,000 (3%, 100-yr) Present Worth = $7,442,000 (7%, 100-yr)	**LOW** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -PCT-C reactive wall construction and periodic ZVI replacement

TABLE 11-6C
DETAILED ANALYSIS OF ALTERNATIVES FOR AREA 5 WEST - GROUNDWATER
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alt	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost	Green Impacts Assessment
5	**Aggressive Extraction (40 New Large Diameter Extraction Wells) + Extraction (PCT-C) + Treat and Discharge Off-site + MNA + ICs + Monitoring** - 2 gpm (0.05 gpm/well) - PCT-C extraction flow - Use 20 gpm system	**YES** -This alternative would be protective of human health and environment. This alternative includes aggressive extraction as a restoration alternative to achieve MCLs for inorganics in groundwater. -This alternative continues the existing extraction at PCT-C and will contain the source with capping impacted soils and prevent off-site migration indefinitely into the future. -The timeframe for aquifer restoration would be several decades ant not significantly less than the previous alternatives. -ICs would control potential exposures to groundwater contamination.	**YES** -This alternative is included as a restoration alternative to reach MCLs. -Chemical-specific ARARs for groundwater will not be met for inorganics for a long time because of the timeframe to reach MCL levels with this aggressive restoration alternative. -This alternative would be in compliance with groundwater ARARs at off-site locations. -Some challenges in meeting action-specific groundwater treatment ARARs and RWQCB and SBCAPCD requirements with this complex groundwater treatment system can be anticipated. This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** -Aggressive extraction at 20 gpm across Area 5 West would reduce inorganic contaminant concentrations at a slightly faster rate. However, the rate of contaminant removal will be very slow because the average concentrations of inorganics in 20 gpm extracted stream will be very low (a few 10s of μg/l). -Would address the RAO of containing sources with the capping of the metals-impacted soil source areas in the RCRA Canyon/WCSA and the closure of the ponds (Pond A-5 and A-Series Pond) as part of the soil remedy. -Would address the off-site migration RAO by continuing operation of the PCT-C extraction feature at the perimeter. -Some COC natural attenuation would occur slowly through dissolution and dispersion and aquifer restoration would still take decades not significantly different from previous alternatives. With ICs and monitoring included there is no potential for exposure to groundwater contaminants.	**MODERATE** -This more aggressive technology would remove contaminant mass at a very low rate (likely < 10 lbs/year for each metal) due to the low extracted groundwater concentrations anticipated in the low 10s of μg/l. -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping of the metals source areas in the RCRA Canyon/WCSA and Pond A-5 and A-Series Pond that would prevent infiltration and minimize leaching. -Clean groundwater would flush in from the north over a long period of time flush the contaminants out. This alternative will continue to remove inorganic contaminants in groundwater at a slow rate by dilution and dispersion that are expected to remain in groundwater for decades.	**MODERATE** -Concerns with potential release of high TDS water to Casmalia Creek due to treatment system failure and resulting non-compliance with NPDES permit limits. This could lead to potential concerns with exposure to ecological species. -Potential for exposures to subsurface contaminants for construction workers/drillers. -Minor risk to human health (on-site workers or community) and environment (potential leaks) during operation of this complex groundwater treatment system.	**POOR TO MODERATE** -Challenges anticipated with complex reverse osmosis and VSEP treatment system and installation of a large number of extraction wells and piping. -Would need to dispose 788,000 gallons of brine a year. We have assumed off-site disposal by truck. If handled on-site, a larger evaporation pond would be needed to handle the reject RO stream. -Challenges with equipment reliability of contaminant removal efficiency. -Large quantities of waste inorganic solids generated in removing high TDS levels estimated at more than 100,000 lbs per year prior to NPDES compliant discharge.	**HIGH** Capital: $12,844,000 Annual Cost: $2,041,000 Present Worth = $51,522,000 (3%, 30-yr) Present Worth = $35,231,000 (7%, 30-yr) Present Worth = $77,471,000 (3%, 100-yr) Present Worth = $39,254,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts are based on energy usage primarily as electricity and fuel usage for: -PCT-C extraction -20 gpm extraction and groundwater treatment system -Large volume of brine that is trucked for off-site disposal -Treatment technology including reverse osmosis, VSEP including electricity for transfer pumps, aeration blowers and LPGAC for polishing. -Emissions during transport and off-site disposal/ regeneration of carbon and filter wastes.

NOTES

1. Effectiveness of each of the active remedial alternatives for groundwater Area 5 West includes the effectiveness benefit of the soil capping remedy for upgradient soil source area locations in FS Area 2 (RCRA Canyon/WCSA) and FS Area 4 (Pond A-5 and A-Series Pond). However, the soil capping remedial components are not formally listed as a component in the remedial alternative.
2. Cost estimates are provided in Appendix E. The cost estimates are approximate (+50%/-30%) and include a contingency of 35 to 50%.
3. Monitoring refers to periodic groundwater monitoring of wells sitewide to monitor performance of the remedial components of the alternatives.
4. Anticipated capping remedies for the site are expected to significantly reduce surface water infiltration and potential for contaminant migration. Anticipated groundwater extraction flow rates are estimated based on groundwater flow modeling.
5. Green impacts assessment is a qualitative rating (low, medium, high) of environmental impacts (footprint) based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative. The higher the rating, the greater the impacts and hence, the less green the alternative.
6. Appendix A presents a time frame for aquifer restoration for Area 5 West to be in the range of 90 years for nickel to 220 years for arsenic assuming source removal. Aquifer restoration time frames with capping of sources and pond closure remedies are expected to be similar to that for source removal. Typically arsenic is present at higher concentrations in groundwater than other metals. Modeling details were presented in Appendix D.

TABLE 12-1
SITE-WIDE REMEDIAL ALTERNATIVE COMPONENTS
Casmalia Resources Superfund Site
Final Feasibility Study

FS Area	Alternative 1 No Action	Alternative 2 Larger Evaporation Pond	Alternative 3 Smaller Evaporation Pond	Alternative 4 No Evaporation Pond	Alternative 5 Smaller Evaporation Pond plus P/S LF Dewatering	Alternative 6 No Evaporation Pond plus Aggressive Site-wide Extraction
Area 1 - Capped Landfills, PCB Landfill, BTA, and CDA						
Capped landfills (P/S, Metals, Caustics, Ac	RCRA Cap (existing)	RCRA Cap (existing)	RCRA Cap (existing)	RCRA Cap (existing)	RCRA Cap (existing)	RCRA Cap (existing)
PCB Landfill	-	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap
BTA	-	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap
CDA	-	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap
Area 2 - RCRA Canyon/WCSA [4]						
8.4-acre RCRA Canyon	-	ET Cap	ET Cap and/or Hybrid Cap	ET Cap and/or Hybrid Cap	ET Cap and/or Hybrid Cap	ET Cap and/or Hybrid Cap
5.5-acre WCSA	-	Excavate/Backfill	ET Cap and/or Hybrid Cap	ET Cap and/or Hybrid Cap	ET Cap and/or Hybrid Cap	ET Cap and/or Hybrid Cap
19.3-acre other areas	-	Stormwater BMPs	ET Cap	ET Cap	ET Cap	ET Cap
Area 3 - Former Ponds/Pads, Roadways, Remaining Onsite Areas, MSA, LTA						
MSA (Location 2)	-	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap
LTA (Location 1)	-	Excavate/Asphalt cap	Excavate/Asphalt cap	Excavate/Asphalt cap	Excavate/Asphalt cap	Excavate/Asphalt cap
Ponds A/B (Location 3)	-	Excavate/PCB LF disposal	Excavate/PCB LF disposal	Excavate/PCB LF disposal	Excavate/PCB LF disposal	Excavate/PCB LF disposal
South of PSCT-1 (Location 4)	-	Excavate/PCB LF disposal	Excavate/PCB LF disposal	Excavate/PCB LF disposal	Excavate/PCB LF disposal	Excavate/PCB LF disposal
RISBON-59 (Location 10)	-	Groundwater Monitoring	Groundwater Monitoring	Groundwater Monitoring	Excavate/PCB LF disposal	Excavate/PCB LF disposal
Area 4 - Ponds						
Pond 18	-	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap	RCRA Cap
Pond A-5	-	Lined Retention Basin	Lined Retention Basin	Lined Retention Basin	Lined Retention Basin	Lined Retention Basin
Pond 13		Lined Retention Basin	Lined Retention Basin	Lined Retention Basin	Lined Retention Basin	Lined Retention Basin
A-Series	-	Evaporation Pond	Eco-Cap/Evaporation Pond	Eco-Cap	Eco-Cap/Evaporation Pond	Eco-Cap
RCF	-	Eco-Cap	Eco-Cap	Eco-Cap	Eco-Cap	Eco-Cap
Area 5N - Groundwater - North						
TI Waiver	-	TI Waiver	TI Waiver	TI Waiver	TI Waiver	TI Waiver
P/S Landfill						
- Gallery Well	Gallery Well	Gallery Well	Gallery Well	Gallery Well	Gallery Well	Gallery Well
- DNAPL/LNAPL Ext Wells (w/ minimal wat	-	DNAPL/LNAPL Extraction	DNAPL/LNAPL Extraction	DNAPL/LNAPL Extraction	-	-
- Landfill dewatering	-	-	-	-	P/S LF de-watering	P/S LF de-watering
Central Drainage Area						
- Sump 9B (Contingency measure)	Sump 9B	Sump 9B	Sump 9B	Sump 9B	Sump 9B	Sump 9B
- LNAPL Extraction Wells (skimming)	-	-	-	-	Convert 4 existing monitoring wells to LNAPL extraction wells	Add 12 new LNAPL skimmer wells
Perimeter Containment						
- Upper HSU	PSCT Ext	PSCT Ext	PSCT Ext	PSCT Ext (Offsite discharge)	PSCT Ext	PSCT Ext (Offsite discharge)
- Lower HSU	-	Monitor 12 new LHSU wells	Monitor 12 new LHSU wells	Monitor 12 new LHSU wells	Monitor 12 new LHSU wells	Extraction from 4 new LHSU wells Monitor 8 new LHSU wells
Monitored Natural Attenuation	-	MNA	MNA	MNA	MNA	MNA
Area 5S - Groundwater - South						
Aggressive extraction	-	-	-	-	-	40 Ext wells
Perimeter Containment	PCT-A/B Extraction	PCT-A/B Extraction	PCT-A/B Extraction	PCT-A/B Extraction (Offsite discharge)	PCT-A/B Extraction	PCT-A/B Extraction (Offsite Discharge)
Monitored Natural Attenuation	-	MNA	MNA	MNA	MNA	MNA
Area 5W - Groundwater - West						
Aggressive extraction	-	-	-	-	-	40 Ext wells (Offsite discharge)
Perimeter Containment	PCT-C Extraction	PCT-C Extraction	PCT-C Extraction	PCT-C Extraction (Offsite discharge)	PCT-C Extraction	PCT-C Extraction (Offsite discharge)
Monitored Natural Attenuation	-	MNA	MNA	MNA	MNA	MNA
Onsite Disposal to Evaporation Pond						
Location	RCF, A-Series, A-5, 18, 13	A-Series (reconstructed, 11 ac)	A-Series (reconstructed, 6 ac)	None	A-Series (reconstructed, 6 ac)	None
Groundwater	PSCT/PCT	PSCT/PCT	PSCT/PCT	-	PSCT/PCT	-
Stormwater	Site-wide, except capped landfill area	Partial RCRA Canyon/WCSA	-	-	-	-
Offsite Disposal to TSDF						
Groundwater/NAPL liquids	-	DNAPL/LNAPL, Gallery Well liquids	DNAPL/LNAPL, Gallery Well liquids	DNAPL/LNAPL, Gallery Well liquids	P/S LF liquids, Gallery Well liquids	P/S LF liquids, Gallery Well liquids
Offsite Disposal to Casmalia Creek						
Groundwater (treated)	-	-	-	PSCT, PCT (treated)	-	PSCT/PCT, P/S LF, 80 (+/-) wells (treated)
Stormwater	Capped Landfills	Entire site, except partial RCRA Canyon/WCSA	Entire site	Entire site	Entire site	Entire site

Notes:
1. RCRA cap includes 2-foot vegetative layer with biotic barrier, geocomposite drainage layer, HDPE geomembrane, GCL, and foundation layer.
2. ET cap is 1-foot compacted (90%) clay foundation and 4-foot vegetative layer that is lightly compacted and amended for vegetative growth.
3. PCB Landfill has a storage capacity of 140,000 cubic yards for wastes from excavations.
4. For Area 2, Alternatives 3 through 6, the final cap may be an ET cap or RCRA Hybrid cap. The cap type and design for the 3 subareas in Area 2 will be determined during remedial design.

TABLE 12-2
DETAILED ANALYSIS OF SITE-WIDE ALTERNATIVES
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Site Wide Remedial Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost[2]	Green Impacts Assessment[5]
SWR #1 No Further Action - Existing containment features including existing caps, PSCT, Gallery Well and PCTs continue extraction operation - Continuation of existing institutional controls - Ponds are not closed	**NO** - Would not be protective because it does not include any additional remediation or long term controls and future owners or construction workers could encounter contamination. - Large volumes of stormwater would need to be managed onsite in ponds - Would not be adequately protective of ecological species with the onsite ponds	**NO** -This alternative would not meet the pond closure requirements and the state rule requiring a restrictive covenant when waste is left in place beyond unrestricted use levels.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not given ratings. - Though this alternative is not rated the costs for this alternative are provided below. Capital = $0 Annual Cost = $2,724,000/year Present Worth = $53,400,000 (3%, 30-yr) Present Worth = $33,807,000 (7%, 30-yr) Present Worth = $86,089,000 (3%, 100-yr) Present Worth = $38,875,000 (7%, 100-yr)	**NOT APPLICABLE** -This alternative does not meet the threshold criteria and hence the balancing criteria are not evaluated.

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SWR #2 Larger Evaporation Pond Area 1: - RCRA cap on PCB Landfill, BTA, and CDA Area 2: - ET cap on west slope RCRA Canyon - Excavate WCSA remedial areas - Grading/BMPs - Stormwater controls Area 3: - RCRA cap on MSA - Excavate Ponds A/B (20') - Excavate hotspot near PSCT-1 (5') - Excavate (5')/Asphalt cap LTA - Groundwater Monitoring at RISBON-59 - Grading/BMPs for Uncapped areas Area 4: - Ecological-cap on RCF Pond - New 11-acre lined evaporation pond in footprint of A-Series Pond - RCRA cap on Pond 18 - Lined retention basin Pond A-5 - Lined retention basin Pond 13 Area 5 N: - Extraction from PSCT and Gallery Well - NAPL-only extraction in P/S Landfill from 16 new wells - Monitoring 12 new LHSU wells - Discharge PSCT groundwater to onsite evaporation pond - GW and soil vapor monitoring Area 5 S: - Extraction from PCT-A and PCT-B - Discharge PCT-A and PCT-B groundwater to onsite evaporation pond - GW and soil vapor monitoring Area 5 W: - Extraction from PCT-C - Discharge PCT-C groundwater to onsite evaporation pond - GW and soil vapor monitoring Stormwater: - Uncapped area stormwater in RCRA Canyon to evaporation pond in A-Series Pond footprint - Offsite discharge of capped area stormwater by General NPDES Permit	**YES** -This alternative would be protective of human health and environment. This remedial alternative continues the existing remedial features and will contain the source and prevent offsite migration indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. -ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North. Rationale for TI waiver presented in Appendix A. There would be applicable chemical specific ARARs for Areas 5 South and 5 West. -This alternative would be in compliance with groundwater ARARs at offsite locations. -Will be in compliance with action-specific ARARs relating to water treatment and vapor control from NAPL storage tanks. -Will be in compliance with ARARs relating to protecting sensitive ecological species from high TDS water in the evaporation pond. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE** -The caps proposed for the PCB Landfill, BTA, CDA, RCRA Canyon and excavation for WCSA, caps or excavation for Hotspot locations in Area 3 and ecological-cap in RCF Pond and HDPE lined A-Series pond effectively controls potential for exposure to contaminants in soil and significantly reduce infiltration through contaminated soil and protect groundwater. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -Construction of a larger 11-acre evaporation pond on the footprint of the A-Series Pond that would require ecological protection and periodic pond dredging and maintenance. Concerns with ecological protection are higher with a larger pond. -LNAPL in Area 5 North is already effectively contained with the PSCT and LNAPL extraction in the CDA is not included. -The capped surfaces will also improve stormwater quality and enable offsite discharge of a large fraction of Site stormwater. But partial cap in Area 2 will result in lower certainty of eliminating seeps. -Grading/BMPs in uncapped areas would reduce erosion and potential contaminant migration through sediments. - There is no residual risk because long term cap maintenance and monitoring, groundwater and soil vapor monitoring and ICs are included.	**POOR TO MODERATE** -Only minor reduction in toxicity, mobility and volume is expected with this alternative that includes source control with PSCT and Gallery well extraction. About 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year that decreases with time. About 1,900,000 gallons of PSCT groundwater treated per year. -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping or excavation of the source areas in soil (FS Areas 1, 2, 3 and 4) that would prevent or reduce infiltration through contaminated soil and minimize leaching to groundwater. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. Contaminants would be flushed in over a long period of time to be captured by the extraction at the PCTs and PSCT. -Natural attenuation especially of the VOCs in Area 5 North and South is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**MODERATE** -Some concerns with NAPL-only vertical well installation in the P/S Landfill with the potential for drilling into waste drums and resulting vapor exposures during drilling. -Some concerns and risks with larger 11-acre pond relating to ecological species protection from high TDS water in evaporation pond -No significant risk of exposure or environmental impacts for other remedial components because the caps would not involve excavation of contaminated soils. -Limited excavation of shallow soils during leveling for cap construction, in WCSA, and in A-Series Pond could pose minor exposure risks for construction workers. -No significant risk to human health or environment during groundwater system operation as this treatment system is already operating at the site.	**MODERATE** - Challenges with a larger 11-acre evaporation pond for providing ecological protection with netting and drift fences and maintenance and dredging of sediments -Challenges with NAPL-only vertical well installation in the P/S Landfill with drilling into waste in landfill -No significant technical challenges except for capping in some sloped areas. The steep slopes will be reduced by the cut/fill grading during the leveling process prior to capping. Borrow soil pre-processing would be necessary for use with the foundation or vegetative layers. -No significant challenges are expected for PSCT and PCT extraction. The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to decrease significantly in the PSCT with the anticipated capping remedies for impacted soil areas and ponds.	**MODERATE TO HIGH** Capital = $53,987,000 Annual Cost = $3,997,400/year Present Worth = $115,445,000 (3%, 30-yr) Present Worth = $85,195,000 (7%, 30-yr) Present Worth = $159,052,000 (3%, 100-yr) Present Worth = $91,956,000 (7%, 100-yr)	**MODERATE** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: - Cut/fill grading of 400,000 cy, excavation of 100,000 cy and borrow soil/compaction for caps of 400,000 cy - Materials manufacture, transport, installation (54 acres HDPE, GCL liner, Pond liner). -PCT-A, PCT-B, PSCT and Gallery Well extraction -GWTS treatment of PSCT groundwater. -NAPL-only extraction -Consumption of materials such as LPGAC and VPGAC associated with the GWTS. -Emissions during transport and offsite disposal of NAPL-only extraction and Gallery Well liquids.

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CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Site Wide Remedial Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost[2]	Green Impacts Assessment[5]
SWR #3 – Smaller Evaporation Pond Area 1: - RCRA cap on PCB Landfill, BTA, and CDA Area 2: - ET cap and/or Hybrid cap on entire RCRA Canyon/WCSA - Excavation WCSA (5')/backfill Area 3: - RCRA cap on MSA - Excavate Ponds A/B (20') - Excavate hotspot near PSCT-1 (5') - Excavate (5')/Asphalt cap LTA - Groundwater Monitoring at RISBON-59 - Grading/BMPs for Uncapped areas Area 4: - Ecological-cap on RCF Pond and portion of A-Series Pond - New 6-acre lined evaporation pond in footprint of A-Series Pond - RCRA cap on Pond 18 - Lined retention basin Pond A-5 - Lined retention basin Pond 13 Area 5 N: - Extraction from PSCT and Gallery Well - NAPL-only extraction in P/S Landfill from 16 wells - Monitoring 12 new LHSU wells - Discharge PSCT groundwater to onsite evaporation pond - GW and soil vapor monitoring Area 5 S: - Extraction from PCT-A and PCT-B - Discharge PCT-A and PCT-B groundwater to onsite evaporation pond - GW and soil vapor monitoring Area 5 W: - Extraction from PCT-C - Discharge PCT-C groundwater to onsite evaporation pond - GW and soil vapor monitoring Stormwater: - Offsite discharge of stormwater from entire site to B-Drainage	**YES** -This alternative would be protective of human health and environment. This remedial alternative continues the existing remedial features and will contain the source and prevent offsite migration indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. -ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North. Rationale for TI waiver presented in Appendix A. There would be chemical specific ARARs for Areas 5 South and 5 West. -This alternative would be in compliance with groundwater ARARs at offsite locations. -Will be in compliance with action-specific ARARs relating to water treatment and vapor control from NAPL storage tanks. -Will be in compliance with ARARs relating to protecting sensitive ecological species from high TDS water in the evaporation pond. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE TO GOOD** - Rated one step higher than SWR #2 because Area 2 includes an ET cap across the entire uncapped area (19.3 acres and 5.5 acres of WCSA) which reduces infiltration, lowers water table and eliminates seeps in the RCRA Canyon. -Construction of a 6-acre evaporation pond as six 1-acre ponds allows for better ecological protection and easier for pond dredging and maintenance -Reduces stormwater management requirement in onsite evaporation pond because the ET cap across the RCRA Canyon/WCSA will allow the discharge offsite as clean under the General NPDES permit. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -Containment of VOCs in Area 5 North is enhanced with the 12 LHSU monitoring wells -LNAPL in Area 5 North is already effectively contained with the PSCT and LNAPL extraction in the CDA is not included. -The caps proposed for the PCB Landfill, BTA, CDA, RCRA Canyon and excavation for WCSA, caps or excavation for Hotspot locations in Area 3 and ecological-cap in RCF Pond and double HDPE lined evaporation pond in the footprint of A-Series pond effectively controls exposure to contaminants in soil and significantly reduce infiltration through contaminated soil and protect groundwater. -The capped surfaces will also improve stormwater quality and enable offsite discharge of a large fraction of Site stormwater. - There is no residual risk because long term cap maintenance and monitoring, groundwater and soil vapor monitoring and ICs are included.	**POOR TO MODERATE** -Rated same as SWR #2 because though the larger ET cap reduces infiltration it does not remove contaminant mass by treatment. Reduces contaminant transport by sediments in stormwater from RCRA Canyon and WCSA. -Only limited reduction in toxicity, mobility and volume by treatment is expected with this alternative that includes source control with PSCT and Gallery well extraction. About 3,000 gal of NAPL from NAPL-only extraction and 450,000 gallons of GW liquids removed per year initially that decreases with time. About 1,900,000 gallons of PSCT groundwater treated per year. -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping or excavation of the source areas in soil (FS Areas 1, 2, 3 and 4) that would prevent or reduce infiltration through contaminated soil and minimize leaching to groundwater. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. Contaminants would be flushed in over a long period of time to be captured by the extraction at the PCTs and PSCT. -Natural attenuation especially of the VOCs in Area 5 North and South is documented and will contribute to mass reduction over the long term (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**MODERATE TO GOOD** -Rated higher than SWR #2 because this alternative uses six 1-acre evaporation ponds which is better for ecological protection. -Some concerns with NAPL-only vertical well installation in the P/S Landfill with the potential for drilling into waste drums and resulting vapor exposures during drilling. -No significant risk of exposure or environmental impacts for other remedial components because the caps would not involve excavation of contaminated soils. -Limited excavation of shallow soils during leveling for cap construction, in WCSA, and in A-Series Pond could pose minor exposure risks for construction workers. -No significant risk to human health or environment during groundwater system operation as this treatment system is already operating at the site.	**MODERATE TO GOOD** - Rated higher than SWR #2 because it uses six 1-acre evaporation ponds which is better suited for ecological protection with construction of netting and drift fences and maintenance and dredging of sediments -No significant technical challenges for capping except in some sloped areas. The steep slopes will be reduced by the cut/fill grading during the leveling process prior to capping. Several vendors available for implementation. Capping is a well-developed technology. -No significant challenges are expected for PSCT and PCT extraction. The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to decrease significantly in the PSCT with the anticipated capping remedies for impacted soil areas and ponds.	**MODERATE TO HIGH** Capital = $59,967,000 Annual Cost = $4,065,400/year Present Worth = $120,224,000 (3%, 30-yr) Present Worth = $89,499,000 (7%, 30-yr) Present Worth = $163,561,000 (3%, 100-yr) Present Worth = $96,218,000 (7%, 100-yr)	**MODERATE** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -Cut/fill grading of 500,000 cy, excavation of 100,000 cy and borrow soil/compaction for caps of 500,000 cy -Materials manufacture, transport, installation (40 acres HDPE, GCL liner, Pond liner). -PCT-A, PCT-B, PSCT and Gallery Well extraction -GWTS treatment of PSCT groundwater. -NAPL-only extraction -Consumption of materials such as LPGAC and VPGAC associated with the GWTS. -Emissions during transport and offsite disposal of Gallery Well liquids.

TABLE 12-2
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CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Site Wide Remedial Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost[2]	Green Impacts Assessment[5]
SWR #4 – No Evaporation Pond Area 1: - RCRA cap on PCB Landfill, BTA, and CDA Area 2: - ET cap and/or Hybrid cap on entire RCRA Canyon and WCSA - Stormwater controls Area 3: - RCRA cap on Location 2 - Excavate Location 3 (20') and Location 4 (5') - Excavate (5') and new asphalt cap on Location 1 - Groundwater monitoring at Location 10 - Grading/BMPs on uncapped areas - Stormwater controls Area 4: - Ecological-cap on RCF Pond and A-Series Pond - RCRA cap on Pond 18 - Lined retention basin Pond A-5 - Lined retention basin Pond 13 Area 5 N: - Extraction from PSCT and Gallery Well - NAPL-only extraction in P/S Landfill from 16 wells - Monitoring in LHSU with 12 new wells - Treat and Discharge PSCT groundwater offsite Area 5 S: - Extraction from PCT-A and PCT-B - Treat and Discharge PCT-A and PCT-B groundwater offsite - MNA Area 5 W: - Extraction from PCT-C - Treat and Discharge PCT-C groundwater offsite - MNA Stormwater: - Offsite disposal of stormwater from entire site to the B-Drainage	**YES** -This alternative would be protective of human health and environment. This remedial alternative continues the existing remedial features and will contain the source and prevent offsite migration indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. -ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North. Rationale for TI waiver presented in Appendix A. There would be chemical specific ARARs for Areas 5 South and 5 West. -This alternative would be in compliance with groundwater ARARs at offsite locations. -Will be in compliance with action-specific ARARs relating to water treatment and vapor control from NAPL storage tanks. -Will be in compliance with ARARs relating to protecting sensitive ecological species from high TDS water in the evaporation pond. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE TO GOOD** - Rated same as SWR #3 except Area 2 includes an ET cap across the entire RCRA Canyon and WCSA which significantly reduces infiltration, lowers the water table and eliminates seeps. -Reduces stormwater management requirement in onsite evaporation pond because the ET cap covers the entire RCRA Canyon and WCSA and will allow the stormwater discharge offsite as clean under the General NPDES permit. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -No onsite evaporation pond is required so no concerns with evaporation pond management and ecological species protection. -The caps proposed for the PCB Landfill, BTA, CDA, RCRA Canyon and excavation for WCSA, caps or excavation for Hotspot locations in Area 3 and ecological-cap in RCF Pond and HDPE lined A-Series pond effectively controls potential for exposure to contaminants in soil and significantly reduce infiltration through contaminated soil and protect groundwater. -The capped surfaces will also improve stormwater quality and enable offsite discharge of a large fraction of Site stormwater. -LNAPL is already effectively contained within the existing site containment features and LNAPL extraction in the CDA is not included. - There is no residual risk because long term cap maintenance and monitoring, groundwater and soil vapor monitoring and ICs are included.	**POOR TO MODERATE** -Rated same as SWR #3 except the ET cap across the RCRA Canyon and WCSA reduces infiltration and provides better protection for groundwater and stormwater. Reduces contaminant transport by sediments in stormwater from RCRA Canyon and WCSA. -Only minor reduction in toxicity, mobility and volume is expected with this alternative that includes source control with PSCT and Gallery well extraction. About 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year initially that decreases with time. About 1,900,000 gallons of PSCT groundwater treated per year. -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping or excavation of the source areas in soil (FS Areas 1, 2, 3 and 4) that would prevent or reduce infiltration through contaminated soil and minimize leaching to groundwater. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. Contaminants would be flushed in over a long period of time to be captured by the extraction at the PCTs and PSCT. -Natural attenuation especially of the VOCs in Area 5 North and South is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**MODERATE** -Rated lower than SWR #3 because it requires onsite treatment for inorganics by reverse osmosis. Reverse osmosis is a complex process which could result in process upsets and discharge of high inorganics laden groundwater to the B-Drainage. -Some concerns with NAPL-only vertical well installation in the P/S Landfill with the potential for drilling into waste drums and resulting vapor exposures during drilling. -No significant risk of exposure or environmental impacts for other remedial components because the caps would not involve excavation of contaminated soils. -Limited excavation of shallow soils during leveling for cap construction, in WCSA, and in A-Series Pond could pose minor exposure risks for construction workers. -No significant risk to human health or environment during groundwater system operation as this treatment system is already operating at the site.	**MODERATE** -Rated lower than SWR #3 though it uses no evaporation ponds because of the challenges associated with reliably treating very high inorganics laden groundwater to stringent NPDES limits. -Administrative implementability challenges with obtaining a site-specific NPDES permit that would require a Basin Plan exception -No significant technical challenges for capping except in some sloped areas. The steep slopes will be reduced by the cut/fill grading during the leveling process prior to capping. Several vendors available for implementation. Capping is a well-developed technology. -No significant challenges are expected for PSCT and PCT extraction. The Groundwater Flow model (Appendix D) shows that total extracted flows are expected to decrease significantly in the PSCT with the increase in the anticipated capping remedies for impacted soil areas and ponds.	**HIGH** Capital = $65,737,000 Annual Cost = $7,772,400/year Present Worth = $195,733,000 (3%, 30-yr) Present Worth = $138,550,000 (7%, 30-yr) Present Worth = $282, 661,000 (3%, 100-yr) Present Worth = $152,025,000 (7%, 100-yr)	**MODERATE TO HIGH** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -Cut/fill grading of 500,000 cy, excavation of 100,000 cy and borrow soil/compaction for caps of 650,000 cy -Materials manufacture, transport, installation (28 acres HDPE, GCL liner, Pond liner). -Operations of 20 gpm system using energy intensive reverse osmosis process to handle PSCT and PCT flows -Large quantities of waste solids for offsite disposal from membranes and filters -PCT-A, PCT-B, PSCT and Gallery Well extraction -GWTS treatment of PSCT groundwater. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS. -Emissions during transport and offsite disposal of Gallery Well liquids.

TABLE 12-2
DETAILED ANALYSIS OF SITE-WIDE ALTERNATIVES
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Site Wide Remedial Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost[2]	Green Impacts Assessment[5]
SWR #5 – Evaporation Pond Plus P/S LF Dewatering Area 1: - RCRA cap on PCB Landfill, BTA, and CDA Area 2: - ET cap and/or Hybrid cap on entire RCRA Canyon and WCSA - Stormwater controls Area 3: - RCRA cap on Location 2 - Excavate Location 3 (20'), Location 4 (5'), Location 10 (50') and dispose in PCB Landfill - Excavate (5') and new asphalt cap on Location 1 - Grading/BMPs on uncapped areas - Stormwater controls Area 4: - Ecological-cap on RCF Pond and portion of A-Series Pond - New 6-acre lined evaporation pond in footprint of A-Series Pond - RCRA cap on Pond 18 - Lined retention basin Pond A-5 - Lined retention basin Pond 13 Area 5 N: - Extraction from PSCT and Gallery Well - De-water P/S Landfill using 5 horizontal wells - NAPL-only extraction in CDA from 4 skimmer wells - Monitoring in LHSU with 12 new wells - Treat and Discharge PSCT groundwater to onsite evaporation pond Area 5 S: - Extraction from PCT-A and PCT-B - Treat and Discharge PCT-A and PCT-B groundwater to onsite evaporation pond - MNA Area 5 W - Extraction from PCT-C - Treat and Discharge PCT-C groundwater to onsite evaporation pond - MNA Stormwater: - Offsite disposal of stormwater from entire site to Casmalia Creek	**YES** -This alternative would be protective of human health and environment. This remedial alternative continues the existing remedial features and will contain the source and prevent offsite migration indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. -ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North. There would be chemical specific ARARs for Areas 5 South and 5 West. -This alternative would be in compliance with groundwater ARARs at offsite locations. -Will be in compliance with action-specific ARARs relating to water treatment and vapor control from NAPL storage tanks. -Will be in compliance with ARARs relating to protecting sensitive ecological species from high TDS water in the evaporation pond. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE TO GOOD** - Rated the same as SWR #3 though it would remove higher amount of contaminant mass by dewatering the P/S Landfill and NAPL-only extraction from 4 wells in the CDA because mass removal is expected to be small fraction of total contaminant mass and it does not significantly reduce long term risk or aquifer restoration timeframe compared to SWR #3. -Groundwater levels are expected to drop in the P/S Landfill even without dewatering as a result of anticipated capping remedies. -Reduces stormwater management requirement in onsite evaporation pond because the ET cap covers the entire RCRA Canyon and WCSA and will allow the stormwater discharge offsite as clean under the General NPDES permit. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable. -The caps proposed for the PCB Landfill, BTA, CDA, RCRA Canyon and excavation for WCSA, caps or excavation for Hotspot locations in Area 3 and ecological-cap in RCF Pond and HDPE lined A-Series pond effectively controls potential for exposure to contaminants in soil and significantly reduce infiltration through contaminated soil and protect groundwater. -Construction of a 6-acre evaporation pond as six 1-acre ponds allows for better ecological protection and easier for pond dredging and maintenance	**MODERATE** -Rated higher than SWR #3 because it would remove a higher contaminant mass by dewatering the P/S Landfill and limited NAPL-only extraction from 4 wells in the CDA. Though contaminant mass removal as a fraction of total site contamination is expected to be small. -Only minor reduction in toxicity, mobility and volume is expected with this alternative that includes source control with PSCT and Gallery well extraction. About 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year initially that decreases with time. About 1,900,000 gallons of PSCT groundwater treated per year. -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping or excavation of the source areas in soil (FS Areas 1, 2, 3 and 4) that would prevent or reduce infiltration through contaminated soil and minimize leaching to groundwater. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. Contaminants would be flushed in over a long period of time to be captured by the extraction at the PCTs and PSCT. -Natural attenuation especially of the VOCs in Area 5 North and South is documented and will contribute to mass reduction (Appendix G). -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**POOR TO MODERATE** -Rated lower than SWR #3 because this alternative involves dewatering P/S Landfill with numerous horizontal wells that pose significant human health and environment concerns such as: - potential release of 1,000s of gallons of liquids in drums into formation - potential for puncturing clay barrier and release of liquids in CDA - potential for drilling muds and liquids release due to upward sloping well due to high pressure at well head. - potential for VOC vapor exposure to drillers and onsite workers. -No significant human health or environmental concerns with NAPL-only extraction from CDA -No significant risk of exposure or environmental impacts for other remedial components because the caps would not involve excavation of contaminated soils. -No significant risk to human health or environment during groundwater system operation as this treatment system is already operating at the site.	**POOR TO MODERATE** -Rated lower than SWR #3 because this alternative involves dewatering P/S Landfill with numerous horizontal wells that pose significant technical challenges such as: - drill bit veering due to borehole guidance system interference from metal drums in waste - blind hole drilling more often result in borehole failure and casing breakage - given the uneven bottom of the landfill, ensuring the borehole tracks the bottom of the landfill (LHSU contact) is very challenging and the best precision achievable may be within 5 or 10 feet of the bottom. -No significant technical challenges for capping except in some sloped areas. The steep slopes will be reduced by the cut/fill grading during the leveling process prior to capping. Several vendors available for implementation. Capping is a well-developed technology. -No significant challenges are expected for PSCT and PCT extraction.	**HIGH** Capital = $69,411,000 Annual Cost = $8,464,000/year Present Worth = $147,035,000 (3%, 30-yr) Present Worth = $113,814,000 (7%, 30-yr) Present Worth = $191,734,000 (3%, 100-yr) Present Worth = $120,744,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -Dewater P/S Landfill five (5) horizontal wells installation -Emissions during transport and offsite disposal of dewater P/S Landfill and Gallery Well liquids of greater than 10,000,000 gallons. First year, there would on average 2 or 3 trucks with liquids daily being loaded and transported on freeways daily. -Cut/fill grading of 500,000 cy, excavation of 100,000 cy and borrow soil/compaction for caps of 650,000 cy -Materials manufacture, transport, installation (40 acres HDPE, GCL liner, Pond liner). -PCT-A, PCT-B, PSCT and Gallery Well extraction -GWTS treatment of PSCT groundwater. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS.

TABLE 12-2
DETAILED ANALYSIS OF SITE-WIDE ALTERNATIVES
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Site Wide Remedial Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs[1]	Long-Term Effectiveness (LTE)	Reduction of Toxicity, Mobility or Volume through Treatment	Short-Term Effectiveness (STE)	Implementability	Cost[2]	Green Impacts Assessment[5]
SWR #6 – Aggressive Sitewide Groundwater Restoration Area 1: - RCRA cap on PCB Landfill, BTA, and CDA Area 2: - ET cap and/or Hybrid cap on entire RCRA Canyon and WCSA - Stormwater controls Area 3: - RCRA cap on Location 2 - Excavate Location 3 (20'), Location 4 (5'), Location 10 (50') and dispose in PCB Landfill - Excavate (5') and new asphalt cap on Location 1 - Grading/BMPs on uncapped areas - Stormwater controls Area 4: - Ecological-cap on RCF Pond and A-Series Pond - RCRA cap on Pond 18 - Lined retention basin at Pond A-5 and Pond 13 - Stormwater controls Area 5 N: - Extraction from PSCT and Gallery Well - De-water P/S Landfill using 5 horizontal wells - NAPL-only extraction in CDA from 12 skimmer wells - Extraction in LHSU with 4 new wells - Monitoring LHSU with 8 new wells - Treat and Discharge PSCT groundwater offsite Area 5 S: - Aggressive extraction from 40 new extraction wells - Extraction from PCT-A and PCT-B - Treat and Discharge groundwater offsite - MNA Area 5 W: - Aggressive extraction with 40 new extraction wells - Extraction from PCT-C - Treat and Discharge groundwater offsite - MNA Stormwater: - Offsite disposal of stormwater from entire site to Casmalia Creek	**YES** -This alternative would be protective of human health and environment. This remedial alternative continues the existing remedial features and will contain the source and prevent offsite migration indefinitely into the future. -The timeframe for aquifer restoration would be hundreds of years. -ICs would control potential exposures to groundwater contamination.	**YES** -Assuming that the TI waiver [1] for groundwater is granted for Area 5 North. -Includes an aggressive 80 well extraction network (30 gpm) and treatment system in an attempt to achieve chemical specific ARARs for Areas 5 South and 5 West. -This alternative would be in compliance with groundwater ARARs at offsite locations. -Will be in compliance with action-specific ARARs relating to water treatment and vapor control from NAPL storage tanks. -Will be in compliance with ARARs relating to protecting sensitive ecological species from high TDS water in the evaporation pond. -This alternative would meet the state ARAR requiring a restrictive covenant when waste is left in place above unrestricted use levels.	**MODERATE TO GOOD** -Rated same as SWR#5 because the additional aggressive 30 gpm extraction will not remove much contaminant mass (<50 lbs of organic and inorganic contaminants/year) because the influent concentrations will be low. - Rated the same as SWR #3 though it would remove higher amount of contaminant mass by dewatering the P/S Landfill, NAPL-only extraction from 12 wells in the CDA and limited LHSU extraction because mass removal is expected to be small fraction of total contaminant mass and it does not significantly reduce long term risk or aquifer restoration timeframe compared to SWR #3. -Reduces stormwater management requirement because the ET cap covers the entire RCRA Canyon and WCSA and will allow the stormwater discharge offsite as clean under the General NPDES permit. -Would address the RAOs for NAPL including DNAPL and LNAPL in the P/S Landfill by removing NAPL to the extent practicable where significant risk reduction occurs. -The caps proposed for the PCB Landfill, BTA, CDA, RCRA Canyon and excavation for WCSA, caps or excavation for Hotspot locations in Area 3 and ecological-cap in RCF Pond and HDPE lined A-Series pond effectively controls potential for exposure to contaminants in soil and significantly reduce infiltration through contaminated soil and protect groundwater. -The capped surfaces will also improve stormwater quality and enable offsite discharge of a large fraction of Site stormwater. -There is no residual risk because long term cap maintenance and monitoring, groundwater and soil vapor monitoring and ICs are included.	**MODERATE** -Rated same as SWR#5 because the additional aggressive 30 gpm extraction will not remove much contaminant mass (<50 lbs of organic and inorganic contaminants/year) because the influent concentrations will be low. -Rated higher than SWR #3 because it would remove a higher contaminant mass by dewatering the P/S Landfill and NAPL-only extraction from 12 wells in the CDA. Though contaminant mass removal as a fraction of total site contamination is expected to be small. -Only minor reduction in toxicity, mobility and volume is expected with this alternative that includes source control with PSCT and Gallery well extraction. About 3,000 gal of NAPL and 450,000 gallons of GW liquids removed per year initially that decreases with time. About 1,900,000 gallons of PSCT groundwater treated per year. -Only modest reduction in toxicity, mobility and volume is expected with this alternative that includes source control with capping or excavation of the source areas in soil (FS Areas 1, 2, 3 and 4) that would prevent or reduce infiltration through contaminated soil and minimize leaching to groundwater. -COC mass reduction by extraction is minor compared to the total contaminant mass at the site. Contaminants would be flushed in over a long period of time to be captured by the extraction at the PCTs and PSCT. -This alternative will continue to remove contaminants in groundwater at a slow rate and aquifer restoration could take hundreds of years.	**POOR** -Rated lower than SWR #5 because the significantly larger 30 gpm treatment system, the complex reverse osmosis system, and the concerns with the potential for release of high inorganics laden groundwater into Casmalia Creek when there is a system upset condition. -Rated lower than SWR #3 because this alternative involves dewatering P/S Landfill with numerous horizontal wells that pose significant human health and environment concerns such as: - potential release of 1,000s of gallons of liquids in drums into formation - potential for puncturing clay barrier and release of liquids in CDA - potential for drilling muds and liquids release due to upward sloping well due to high pressure at well head. - potential for vapor exposure to drillers and onsite workers. -Extracted PSCT and PCT groundwater requires onsite treatment for inorganics with reverse osmosis, which is a complex process that could result in process upsets and discharge of high inorganics laden groundwater to Casmalia Creek. -No significant human health or environmental concerns with NAPL-only extraction from CDA or LHSU extraction -No significant risk to human health or environment during groundwater system operation as this treatment system is already operating at the site.	**POOR** -Rated lower than SWR#5 because it includes aggressive hydraulic extraction with 80 new wells across the entire Area 5 South and 5 West in an attempt to reach MCLs. -Rated lower than SWR #3 because this alternative involves dewatering P/S Landfill with numerous horizontal wells that pose significant technical challenges such as: - drill bit veering due to borehole guidance system interference from metal drums in waste - blind hole drilling more often result in borehole failure and casing breakage - given the uneven bottom of the landfill, ensuring the borehole tracks the bottom of the landfill (LHSU contact) is very challenging and the best precision achievable may be within 5 or 10 feet of the bottom. -Rated lower than SWR #3 though it uses no evaporation ponds because of the challenges associated with reliably treating very high inorganics laden groundwater to stringent NPDES limits. -Administrative implementability challenges with obtaining a site-specific NPDES permit that would require a Basin Plan exception - No significant challenges are expected for PSCT and PCT extraction.	**HIGH** Capital = $93,245,000 Annual Cost = $14,849,000/year Present Worth = $291,069,000 (3%, 30-yr) Present Worth = $209,924,000 (7%, 30-yr) Present Worth = $412,474,000 (3%, 100-yr) Present Worth = $228,744,000 (7%, 100-yr)	**HIGH** Green and sustainability impacts are based on electricity and fuel usage and GHG emissions for: -Installation 80 extraction wells and piping/trenching and 30 gpm treatment system installation. -Operations of 30 gpm system using energy intensive reverse osmosis -Large quantities of waste solids for offsite disposal -Dewater P/S Landfill five (5) horizontal wells installation -Emissions during transport and offsite disposal of dewater P/S Landfill and Gallery Well liquids of greater than 10,000,000 gallons. First year, there would on average 2 or 3 trucks with liquids daily being loaded and transported on freeways daily. -Cut/fill grading of 500,000 cy, excavation of 100,000 cy and borrow soil/compaction for caps of 650,000 cy -Materials manufacture, transport, installation (28 acres HDPE, GCL liner, Pond liner). -PCT-A, PCT-B, PSCT and Gallery Well extraction -GWTS treatment of PSCT groundwater. -Consumption of materials such as LPGAC and VPGAC associated with the GWTS.

TABLE 12-2
DETAILED ANALYSIS OF SITE-WIDE ALTERNATIVES
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

NOTES

1. A TI (Technical Impracticability) waiver of chemical-specific groundwater ARARs for Area 5 North as presented in the TI evaluation (Appendix A) is assumed to be granted by the USEPA. Appendix B provides the list of ARARs considered in the FS.
2. Cost estimates are provided in Appendix E. The cost estimates are approximate (+50%/-30%) and include a contingency of 35 to 50%.
3. Monitoring refers to periodic groundwater monitoring of wells site-wide to monitor performance of the remedial components of the alternatives.
4. Anticipated capping remedies for the site are expected to significantly reduce surface water infiltration and potential for contaminant migration. Also, groundwater extraction flow rates are expected to decrease based on groundwater flow modeling.
5. Green impacts assessment is a qualitative rating of environmental impacts (footprint) based on equipment use for excavation, soil loading/transporting, and compacting equipment, their emissions and fuel and water use for excavation, cap and drainage construction, and materials manufacture, transport and installation use of fuels and GHG footprint, for each alternative. The higher the rating, the greater the impacts and hence, the less green the alternative.

TABLE 12-3
SUMMARY OF AREA-SPECIFIC REMEDIAL ALTERNATIVES EVALUATION
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alternatives and Evaluation Criteria	Area-Specific Screening Evaluation [1]				Area-Specific Detailed Evaluation [2]									Site-wide Alternatives					
	Effectiveness	Implemen-tability	Cost	Green Assessment	Alt	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness	Reduction in Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implemen-tability	Cost	Green Assessment	1	2	3 [4]	4 [4]	5 [4]	6 [4]
Area 1 - PCB Landfill, Burial Trench Area (BTA), and Central Drainage Area (CDA) Existing Capped Landfills Area																			
1. No Action	○	N/A	None	None	1	No	No	N/A	N/A	N/A	N/A	None	None	●					
2. RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring	◕	●	◔	◑	2	Yes	Yes	◕	○	◕	●	◔	◑						
3. Evapotranspirative (ET) Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring	◕	●	◔	◑	3	Yes	Yes	◕	○	◕	●	◔	◑						
4. RCRA Cap (PCB Landfill, BTA, CDA) + Stormwater Controls + ICs + Monitoring	◕	●	◔	◑	4	Yes	Yes	◕	○	◕	●	◔	◑		●	●	●	●	●
5. Excavate (BTA, CDA remedial areas) (5')/Offsite Disposal + RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring	◕	◕	○	◔	*														
6. Excavate (Entire BTA (20') + CDA remedial area (5'))/Offsite Disposal + RCRA-Equivalent Mono Soil Cap (BTA, CDA) (5') + RCRA Cap (PCB Landfill) + Stormwater Controls + ICs + Monitoring	◕	◑	○	○	5	Yes	Yes	◑	◔	◔	◑	○	○						
Area 2 - RCRA Canyon and West Canyon Spray Area (WCSA)																			
1. No Action	○	N/A	None	None	1	No	No	N/A	N/A	N/A	N/A	None	None	●					
2. Eco-Cap (West slope RCRA Canyon, WCSA remedial area) (2') + Grading/BMPs (Uncapped areas) + Stormwater Controls + ICs + Monitoring	◑	◑	◔	◑	2	Yes	Yes	◔	○	◕	◕	◑	◕						
3. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon) (5') + Excavate (WCSA remedial area) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls (Segregate Capped and Uncapped Area SW) + ICs + Monitoring	◕	◕	◔	◑	3	Yes	Yes	◑	○	◕	◕	◑	◑		●				
4. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon, WCSA remedial area) (5') + Grading/BMPs (Uncapped areas) + Stormwater Controls + ICs + Monitoring	◕	◕	◔	◑	4	Yes	Yes	◑	○	◕	◕	◑	◑						
5. RCRA-Equivalent Mono Soil Cap (West slope RCRA Canyon) (5') + Excavation (WCSA remedial area) (5') + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls (Segregate Capped and Uncapped Area SW) + ICs + Monitoring	◕	◑	◔	◔	5	Yes	Yes	◕	○	◕	◑	◔	◔						
6. RCRA-equivalent Hybrid Cap (West slope RCRA Canyon) (5') + Excavation (WCSA remedial area) + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring	◕	◑	◔	◔	6	Yes	Yes	◕	○	◕	◑	◔	◔						
7. Evapotranspirative (ET) Cap (West slope RCRA Canyon) (5') + Excavation (WCSA remedial area) + Clean Soil Cover (Uncapped Areas) (2') + Stormwater Controls + ICs + Monitoring	◕	◑	◔	◔	7	Yes	Yes	◕	○	◕	◑	◔	◔						
8. RCRA Equivalent Hybrid Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring	●	◑	○	○	8	Yes	Yes	●	○	◕	◑	○	○			●	●	●	●
9. Evapotranspirative (ET) Cap (entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring	●	◑	○	○	9	Yes	Yes	●	○	◕	◑	○	○			●	●	●	●
10. RCRA Cap (Entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring	●	◔	○	○	*														
Area 3 - Former Ponds and Pads, Remaining Oniste Areas																			
1. No Action	○	N/A	None	None	1	No	No	N/A	N/A	N/A	N/A	None	None	●					
2. Eco-Cap (Locations 2, 3, 4) (2') + New Asphalt Cap (Location 1) + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring	◑	◑	◔	◑	*														
3. RCRA Cap (Locations 2, 3, 4) + Excavate/New Asphalt Cap (Location 1) (5') + GW Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring	●	◕	◔	◑	2	Yes	Yes	◕	○	●	◕	◔	◑						
4. RCRA Cap (Locations 2) + Excavate ((Location 3) (20'); (Location 4) (5')) + Excavate/New Asphalt Cap (Location 1) (5') + Groundwater Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring	●	◕	◔	◑	3	Yes	Yes	◕	◔	◕	◕	◔	◑		●	●	●		

TABLE 12-3
SUMMARY OF AREA-SPECIFIC REMEDIAL ALTERNATIVES EVALUATION
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alternatives and Evaluation Criteria	Area-Specific Screening Evaluation [1]				Area-Specific Detailed Evaluation [2]									Site-wide Alternatives					
	Effectiveness	Implemen-tability	Cost	Green Assessment	Alt	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness	Reduction in Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implemen-tability	Cost	Green Assessment	1	2	3 [4]	4 [4]	5 [4]	6 [4]
5. RCRA Cap (Location 2) + Excavate ((Location 3) (20'); (Location 4) (5'); (Location 10) (50'))/Place in PCB Landfill + Excavate/New Asphalt Cap (Location 1) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring	●	◕	◔	◑	4	Yes	Yes	◕	◔	◑	◑	◔	◔					●	●
6. Excavate (Locations 2, 4) (5')/Place in PCB Landfill + Excavate (Location 3) (20')/Offsite Disposal + Excavate/Asphalt Cap (Location 1) (5') + In-situ Thermal Desorption (Location 10) (5'-50' bgs) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring	◑	◑	○	○	*														
7. Excavate (Locations 2, 4) (5') + Excavate (Location 3) (20') and (Location 10) (50')/Offsite Disposal + Excavate/Asphalt Cap (Location 1) (5') + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring	◕	◑	○	○	5	Yes	Yes	◑	◔	◑	◑	○	○						
Area 4 - Stormwater Ponds and Treatment Liquid Impoundments																			
1. No Action	○	N/A	None	None	1	No	No	N/A	N/A	N/A	N/A	None	None	●					
2. Eco-Cap (RCF, A-Series Pond) (2') + Construct New 11-Acre Evaporation Pond + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring	◑	◑	○	○	2	Yes	Yes	◑	○	◑	◑	○	◔						
3. Eco-Cap (RCF Pond, Segregate East RCF) (2') + Construct Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring	◑	◑	◔	◔	3	Yes	Yes	◕	○	◑	◑	◑	◑						
4. Eco-Cap (RCF Pond) (2') + Construct 11-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring	◑	◑	◔	◔	4	Yes	Yes	◕	○	◑	◑	◑	◑		●				
5. Eco-Cap (RCF Pond, portion of A-Series Pond) + Construct 6-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring	◕	◕	◑	◑	5	Yes	Yes	◕	○	◕	◕	◑	◑			●		●	
6. Eco-Cap (RCF Pond, A-Series Pond) (2') + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring	◕	◕	◑	◑	6	Yes	Yes	◕	○	◕	◕	◑	◑				●		●
7. ET Cap (RCF Pond, portion of A-Series Pond) + Construct 6-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring	◕	◕	◔	◔	7	Yes	Yes	◕	○	◕	◕	◔	◔						
8. Excavate/Clean Backfill (RCF Pond, A-Series Pond) + Construct New 11-Acre Lined Evaporation Pond (North of RCF Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring	◑	◑	○	○	8	Yes	Yes	◑	◔	◔	◑	○	○						
9. RCRA Cap (RCF Pond, Pond 18) (5') + Construct New 11-Acre Lined Evaporation Pond (A-Series Pond) + Lined Retention Basin (Pond A-5, Pond 13) + Stormwater Controls + ICs + Monitoring	◕	◑	○	○	*														
Area 5N - Groundwater North																			
1. No Action	○	N/A	None	None	1	No	No	N/A	N/A	N/A	N/A	None	None	●					
2. Extraction (PSCT, Gallery Well) + Treat and Discharge PSCT Groundwater to Onsite Evaporation Pond + ICs + Monitoring	◔	●	◑	◕	2	Yes	Yes	◔	○	●	●	◑	◕						
3. Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 new LHSU wells) + Treat and Discharge PSCT Groundwater to Onsite Evaporation Pond + ICs + Monitoring	◕	◕	◔	◑	3	Yes	Yes	◑	◔	◕	◕	◔	◑		●	●			
4. Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 new LHSU wells) + Treat and Discharge PSCT Groundwater Offsite (No Onsite Evaporation Pond) + ICs + Monitoring	◕	◑	○	◔	4	Yes	Yes	◑	◔	◑	◑	○	◔				●		

TABLE 12-3
SUMMARY OF AREA-SPECIFIC REMEDIAL ALTERNATIVES EVALUATION
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

Alternatives and Evaluation Criteria	Area-Specific Screening Evaluation [1]				Area-Specific Detailed Evaluation [2]									Site-wide Alternatives					
	Effectiveness	Implemen-tability	Cost	Green Assessment	Alt	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness	Reduction in Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implemen-tability	Cost	Green Assessment	1	2	3 [4]	4 [4]	5 [4]	6 [4]
5. Extraction (PSCT, Gallery Well) + Extraction (Aggressive, 16 large Diameter NAPL Wells) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 new LHSU wells) + Treat and Discharge to Onsite Evaporation Pond + ICs + Monitoring	◕	◑	○	○	5	Yes	Yes	◑	◑	◔	◔	○	○						
6. Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells) + Extraction (NAPL-only in CDA, 4 new wells) + Monitoring (12 new LHSU wells) + Treat and Discharge to Onsite Evaporation Pond + ICs + Monitoring	◕	◔	○	○	6	Yes	Yes	◑	◑	◔	◔	○	○					●	
7. Extraction (PSCT, Gallery Well) + Dewater P/S Landfill (5 Horizontal Wells) + Extraction (NAPL-only in CDA, 12 new wells) + Extraction (4 new LHSU wells) + Monitoring (8 new LHSU wells) + Treat and Discharge Offsite + ICs + Monitoring	◕	◔	○	○	7	Yes	Yes	◑	◑	◔	◔	○	○						●
8. Aggressive Extraction (50 Large Diameter Wells) + Extraction (Aggressive, 16 Large Diameter NAPL Wells in P/S Landfill)+ Extraction (PSCT, Gallery Well) + Treat and Discharge Offsite + ICs + Monitoring	◕	◔	○	○	*														
Area 5S - Groundwater South																			
1. No Action	○	N/A	None	None	1	No	No	N/A	N/A	N/A	N/A	None	None	●					
2. Extraction (PCT-A, PCT-B) + Treat/Discharge to Onsite Evaporation Pond + MNA + ICs + Monitoring	◑	●	◕	◕	2	Yes	Yes	◑	◔	●	●	◕	◑		●	●		●	
3. Extraction (PCT-A, PCT-B) + Treat and Discharge Offsite + MNA + ICs + Monitoring	◑	◑	◔	◔	3	Yes	Yes	◑	◔	◑	◑	◔	◔				●		
4. Extraction (PCT-A) + In-situ Reactive Wall (PCT-B) + MNA + ICs + Monitoring	◔	◕	◑	●	4	Yes	Yes	◔	◔	◕	◑	◑	◕						
5. Extraction (PSCT Westside Extension) + Extraction (PCT-A, PCT-B) + MNA + ICs + Monitoring	◑	◑	◔	◔	*														
6. Aggressive Extraction (40 New Large Diameter Wells) + Extraction (PCT-A, PCT-B) + Treat and Discharge Offsite + MNA + ICs + Monitoring	◑	◔	○	○	5	Yes	Yes	◑	◑	◑	◔	○	○						●
Area 5W - Groundwater West																			
1. No Action	○	N/A	None	None	1	No	No	N/A	N/A	N/A	N/A	None	None	●					
2. Monitored Natural Attenuation + ICs	○	●	●	None	*														
3. Extraction (PCT-C) + Treat and Discharge to Onsite Evaporation Pond + MNA + ICs + Monitoring	◑	●	◕	◕	2	Yes	Yes	◑	◔	●	●	◑	◕		●	●		●	
4. Extraction (PCT-C) + Treat and Discharge Offsite + MNA + ICs + Monitoring	◑	◑	◔	◔	3	Yes	Yes	◑	◔	◑	◑	◔	◔				●		
5. In-Situ Reactive Wall (PCT-C) + MNA + ICs + Monitoring	◔	◕	◑	●	4	Yes	Yes	◔	◔	◕	◑	◑	●						
6. Aggressive Extraction (40 New Large Diameter Wells) + Extraction (PCT-C) + Treat and Discharge Offsite + MNA + ICs + Monitoring	◑	◔	○	○	5	Yes	Yes	◑	◑	◑	◔	○	○						●

Notes

1. Summarizes information in Tables 10-1 through 10-6C.
2. Summarizes information in Tables 11-1 through 11-6C.
3. (*) Shaded cell indicate that the alternative was screened-out.

Balancing Criteria (except cost)

○	Poor	◕	Moderate to good
◔	Poor to Moderate	●	Good
◑	Moderate		
◑	Moderate		

Cost and Green Assessment Impacts

●	Low	◔	Moderate to High
◕	Low to Moderate	○	High
◑	Moderate		
◑	Moderate		

● Site-wide Alternative Component

Top Ranked Site-Wide Alternative

TABLE 12-4
COST ESTIMATE FOR SITE-WIDE REMEDIAL ALTERNATIVES #2 TO #6
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

SWR Alt #	SITEWIDE REMEDIAL ALTERNATIVE	CAPITAL COST (2014 $)	ANNUAL O&M COST (2014 $)	TIME FRAME	PRESENT WORTH CAPITAL + O&M 3% DISCOUNT RATE (2014 $)	PRESENT WORTH CAPITAL + O&M 7% DISCOUNT RATE (2014 $)
2	Larger Evaporation Pond FS Area 1 Alt 4 + FS Area 2 Alt 3[5] + FS Area 3 Alt 3 + FS Area 4 Alt 4 + FS Area 5N Alt 3 + FS Area 5S Alt 2 + FS Area 5W Alt 2	$ 53,987,000	$ 3,997,000	30-year	$115,445,000	$85,195,000
				100-year	$159,052,000	$91,956,000
3	Smaller Evaporation Pond FS Area 1 Alt 4 + FS Area 2 Alt 9 + FS Area 3 Alt 3 + FS Area 4 Alt 5 + FS Area 5N Alt 3 + FS Area 5S Alt 2 + FS Area 5W Alt 2	$ 59,967,000	$ 4,065,000	30-year	$120,224,000	$89,499,000
				100-year	$163,561,000	$96,218,000
4	No Evaporation Pond FS Area 1 Alt 4 + FS Area 2 Alt 9 + FS Area 3 Alt 3 + FS Area 4 Alt 6 + FS Area 5N Alt 4 + FS Area 5S Alt 3 + FS Area 5W Alt 3	$ 65,737,000	$ 7,772,000	30-year	$195,733,000	$138,550,000
				100-year	$282,661,000	$152,025,000
5	Evaporation Pond Plus P/S Landfill De-watering FS Area 1 Alt 4 + FS Area 2 Alt 9 + FS Area 3 Alt 4 + FS Area 4 Alt 5 + FS Area 5N Alt 6 + FS Area 5S Alt 2 + FS Area 5W Alt 2	$ 69,411,000	$ 8,464,000	30-year	$147,035,000	$113,814,000
				100-year	$191,734,000	$120,744,000
6	Aggressive Site-Wide Extraction with No Evaporation Pond FS Area 1 Alt 4 + FS Area 2 Alt 9 + FS Area 3 Alt 4 + FS Area 4 Alt 6 + FS Area 5N Alt 7 + FS Area 5S Alt 5 + FS Area 5W Alt 5	$ 93,245,000	$ 14,849,000	30-year	$291,069,000	$209,924,000
				100-year	$412,474,000	$228,744,000

NOTES

1. Present Worth Capital Costs are shown for a 3% and 7% net discount rate based on an average capital expenditure (remedy construction) for each year of the 5-year construction period.
2. Total Present Worth Capital + O&M Cost is shown for a 3% and 7% net discount rate and a 30-year and a 100-year timeframe and includes contingency on capital and O&M costs.
3. FS Remedy construction will take 5 years (projected to occur from 2016 to 2020). Annual O&M Costs post construction begin in 2021. Please note prior to and during construction the site will continue to incur O&M and EPA oversight costs.
4. Total Present Worth Cost (Capital + O&M) is assumed to be the sum of the present worth cost for individual alternative components from each FS Area that compose the sitewide remedial alternativ
5. For SWR Alternative 2, Area 2 is remediated by constructing an ET cap over the western slopes of the RCRA Canyon, instead of a RCRA mono soil cap originally specified in Area 2 Alternative 3. The original Alternative 3 cost sheet was modified to incorporate the ET cap.

TABLE 12-5
SUMMARY OF SITE-WIDE REMEDIAL ALTERNATIVES EVALUATION
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

	Evaluation Criteria	Alternative 1 No Action	Alternative 2 Larger Evaporation Pond	Alternative 3 Smaller Evaporation Pond	Alternative 4 No Evaporation Pond	Alternative 5 Evaporation Pond plus P/S LF Dewatering	Alternative 6 No Evaporation Pond plus Aggressive Site-wide Extraction
1	Overall Protection of Human Health and the Environment	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
2	Compliance with ARARs	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
3	Long-Term Effectiveness	**N/A**	◑	◕	◕	◕	◕
4	Reduction of Toxicity, Mobility or Volume through Treatment	**N/A**	◔	◔	◔	◑	◑
5	Short-Term Effectiveness	**N/A**	◑	◕	◑	◔	○
6	Implementability	**N/A**	◑	◕	◑	◔	○
7	Cost	**N/A**	◔	◔	○	○	○
8	Green Impacts Assessment	**N/A**	◔	◑	◔	○	○
	Capital (2014 $)	$0	$53,987,000	$59,967,000	$65,737,000	$69,411,000	$93,245,000
	Annual O&M (2014 $)	$2,724,000	$3,997,000	$4,065,000	$7,772,000	$8,464,000	$14,849,000
	Capital + O&M, 30-year, 3%	$53,400,000	$115,445,000	$120,224,000	$195,733,000	$147,035,000	$291,069,000
	Capital + O&M, 30-year, 7%	$33,807,000	$85,195,000	$89,499,000	$138,550,000	$113,814,000	$209,924,000
	Capital + O&M, 100-year, 3%	$86,089,000	$159,052,000	$163,561,000	$282,661,000	$191,734,000	$412,474,000
	Capital + O&M, 100-year, 7%	$38,875,000	$91,956,000	$96,218,000	$152,025,000	$120,744,000	$228,744,000

Balancing Criteria (except cost)

- ○ Poor
- ◔ Poor to Moderate
- ◑ Moderate
- ◕ Moderate to good
- ● Good

Cost and Green Impacts Assessment

- ● Low
- ◕ Low to Moderate
- ◑ Moderate
- ◔ Moderate to High
- ○ High

Notes

1. This table summarizes information in Table 12-2, Detailed Analysis of Site-wide Alternatives.

TABLE 12-6
COST ESTIMATE SUMMARY FOR TOP-RANKED SITEWIDE REMEDIAL ALTERNATIVE #3
CASMALIA RESOURCES SUPERFUND SITE FINAL FEASIBILITY STUDY

FS Area	Description	Remedial Alternative Component	Capital Costs 2014 $	Annual O&M Costs 2014 $	Present Worth Capital + O&M Costs (2014 $)		
					O&M Timeframe	Discount Rate	
						3%	7%
1	PCB Landfill, BTA, CDA, Capped Landfills Area – P/S Landfill, EE/CA Area	RCRA Cap (PCB Landfill, BTA, CDA) + Stormwater Controls + ICs + Monitoring	$14,018,000	$318,000	30-Year	$18,793,000	$14,749,000
					100-Year	$23,806,000	$15,526,000
2	RCRA Canyon, WCSA	Evapotranspirative (ET) Cap (entire RCRA Canyon, WCSA) + Stormwater Controls + ICs + Monitoring	$15,655,000	$473,000	30-Year	$23,301,000	$17,936,000
					100-Year	$30,322,000	$19,024,000
3	Former Ponds and Pads, Remaining On-Site Areas, Roadways, Liquids Treatment Area, Maintenance Shed Area	RCRA Cap (Locations 2) + Excavate ((Location 3) (20'); (Location 4) (5')) + Excavate/New Asphalt Cap (Location 1) (5') + Groundwater Monitoring (Location 10) + Grading/BMPs (Uncapped Areas) + Stormwater Controls + ICs + Monitoring	$6,681,000	$196,000	30-Year	$9,888,000	$7,619,000
					100-Year	$12,814,000	$8,072,000
4	Stormwater Ponds and Treated Liquid Impoundments – A-Series Pond, RCF Pond, Pond A-5, Pond 13, Pond 18	Eco-Cap (RCF Pond, portion of A-Series Pond) + Construct 6-acre Lined Evaporation Pond (A-Series Pond) + RCRA Cap (Pond 18) + Lined Retention Basin (Ponds A-5, 13) + Stormwater Controls + ICs + Monitoring	$13,131,000	$386,000	30-Year	$21,621,000	$16,287,000
					100-Year	$30,318,000	$17,636,000
5N	Groundwater, Area 5 North	Extraction (PSCT, Gallery Well) + Extraction (NAPL-only in P/S Landfill) + Extraction (NAPL-only in CDA, 4 wells) + Monitoring (12 new LHSU wells) + Treat and Discharge PSCT Groundwater to Onsite Evaporation Pond + ICs + Monitoring	$6,068,000	$2,128,000	30-Year	$31,445,000	$22,402,000
					100-Year	$43,294,000	$24,240,000
5S	Groundwater, Area 5 South	Extraction (PCT-A, PCT-B) + Treat/Discharge to Onsite Evaporation Pond + MNA + ICs + Monitoring	$1,781,000	$305,000	30-Year	$7,667,000	$5,216,000
					100-Year	$11,863,000	$5,867,000
5W	Groundwater, Area 5 West	Extraction (PCT-C) + Treat and Discharge to Onsite Evaporation Pond + MNA + ICs + Monitoring	$2,633,000	$258,000	30-Year	$7,509,000	$5,290,000
					100-Year	$11,144,000	$5,853,000
		Total Present Worth Cost Estimate :	$59,967,000	$4,064,000	30-Year	$120,224,000	$89,499,000
					100-Year	$163,561,000	$96,218,000

NOTES:
1. Present Worth of Capital Costs are 2014 $ based on an average capital expenditure for each year of the 5-year construction period using a net discount rate of 3% and 7%.
2. Total Present Worth of Capital + O&M costs are 2014 $ based on 30-year and 100-year timeframes and include a 35 to 50% contingency.
3. The costs are presented using a net discount rate of 3% and 7% as suggested in EPA guidance and are consistent with current expected inflation and return on investments.
4. For FS Area 2, the selected remedy would use either an ET or Hybrid cap but the cost estimate here assumes an ET cap.